INTERNATIONAL WORKSHOP ON EARTH OBSERVATION FOR SEEA COMPLIANT NATURAL CAPITAL ACCOUNTING

LIFE IP 4 Nature in Greece

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Life

NATURA 2000

GREEN FUND

Athens, Wednesday, May, 22

The project LIFE-IP 4 NATURA

LIFE-IP 4 NATURA

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Natura 2000

edozoume.gr

- ✓ enhance Greece's nature conservation framework
- ✓ ensures the country's compliance with the European Union's nature legislation
- ✓ integrates actions covering all aspects of nature protection: policy, economy, society and science.

Partnership

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Natura 2000

Ecosystem type map of Greece outside Natura 2000 SACs

Introduction: Background and Motivation

LULC products:
- proxies for Ecosystem Types
- key input for ES models

EO data:
- spatially continuous, timely and accurate information
- global, continental and regional LULC products

Large scale LULC efforts
<u>limitations:</u>
- diverse input data
- accuracy variability
- coarse update intervals
- coarse thematic resolution
- coarse MMU

Technology:
- ✓ EO imagery:
  - open-access
  - medium-high spatial resolution
  - high temporal resolution
- ✓ Cloud computing platforms
- ✓ ARD

Need for
- timely, on-demand LC datasets
- end-to-end automated workflows

Challenges:
- large multi-temporal, multi-sensor datasets
- plethora of processing algorithms
- reference data

Introduction: Main objectives

- ✓classification workflow
- ✓fine-scale LC product for ES mapping

- EU MAES, EU Biodiversity Strategy to 2020
- 21 classes (MAES 3rd level)
- 10m Sentinel-1 and Sentinel-2
- OBIA
- use of Copernicus geospatial information for collecting reference data

Additional objectives

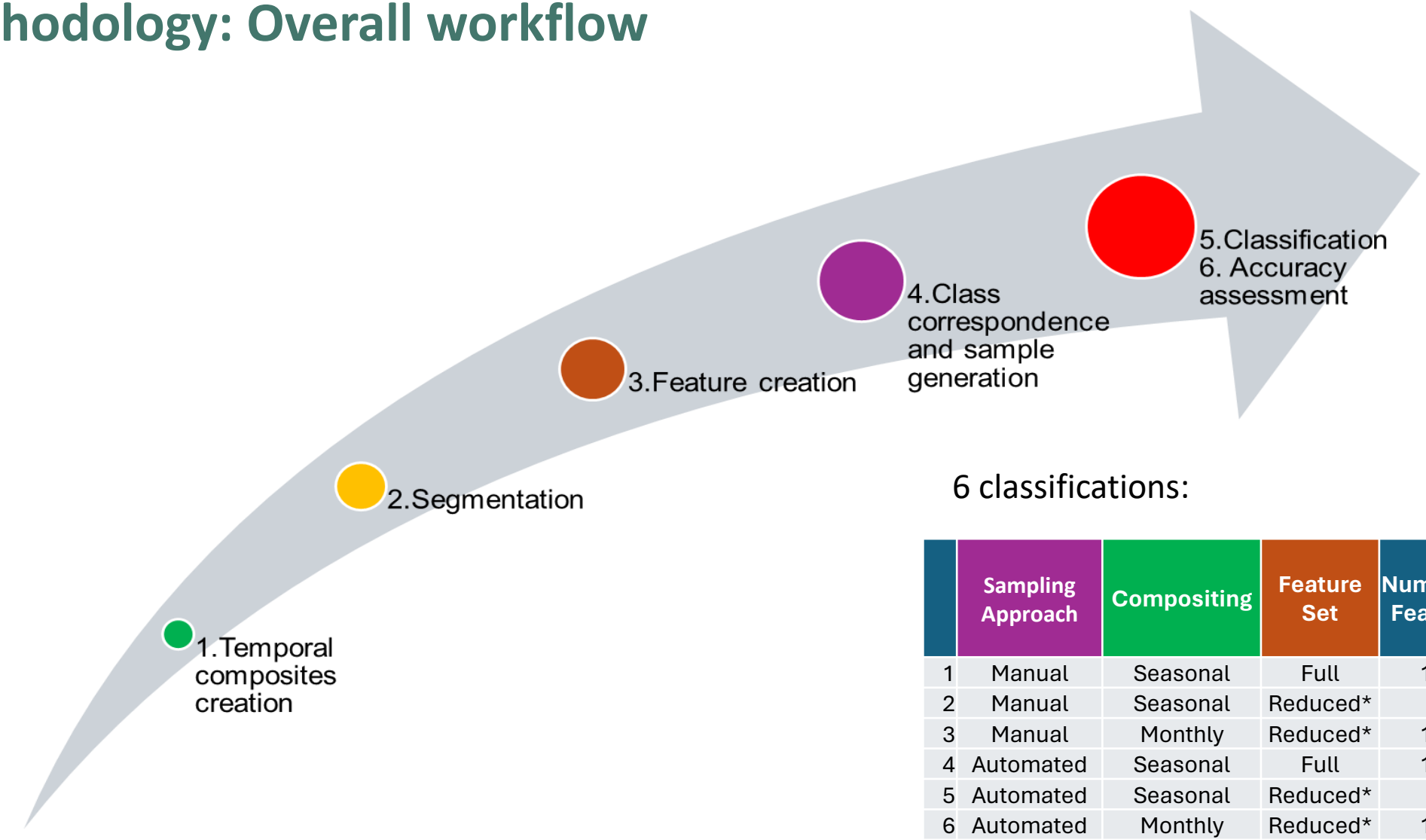
- ✓ 2 training data extraction strategies (manual VS automated)
- ✓ 2 temporal compositing strategies (seasonal VS monthly)
- ✓ different features for classification

Introduction: Study area - Greece

- ~ 131,957 km^2
- ~ 78% mountains
- largest coastline in EU
- highly diverse landscape
- multiple climate classification
- large Ecosystem variety
- forests ~37%

Only CORINE and Ecosystem Type Map of Europe available

Methodology: Overall workflow

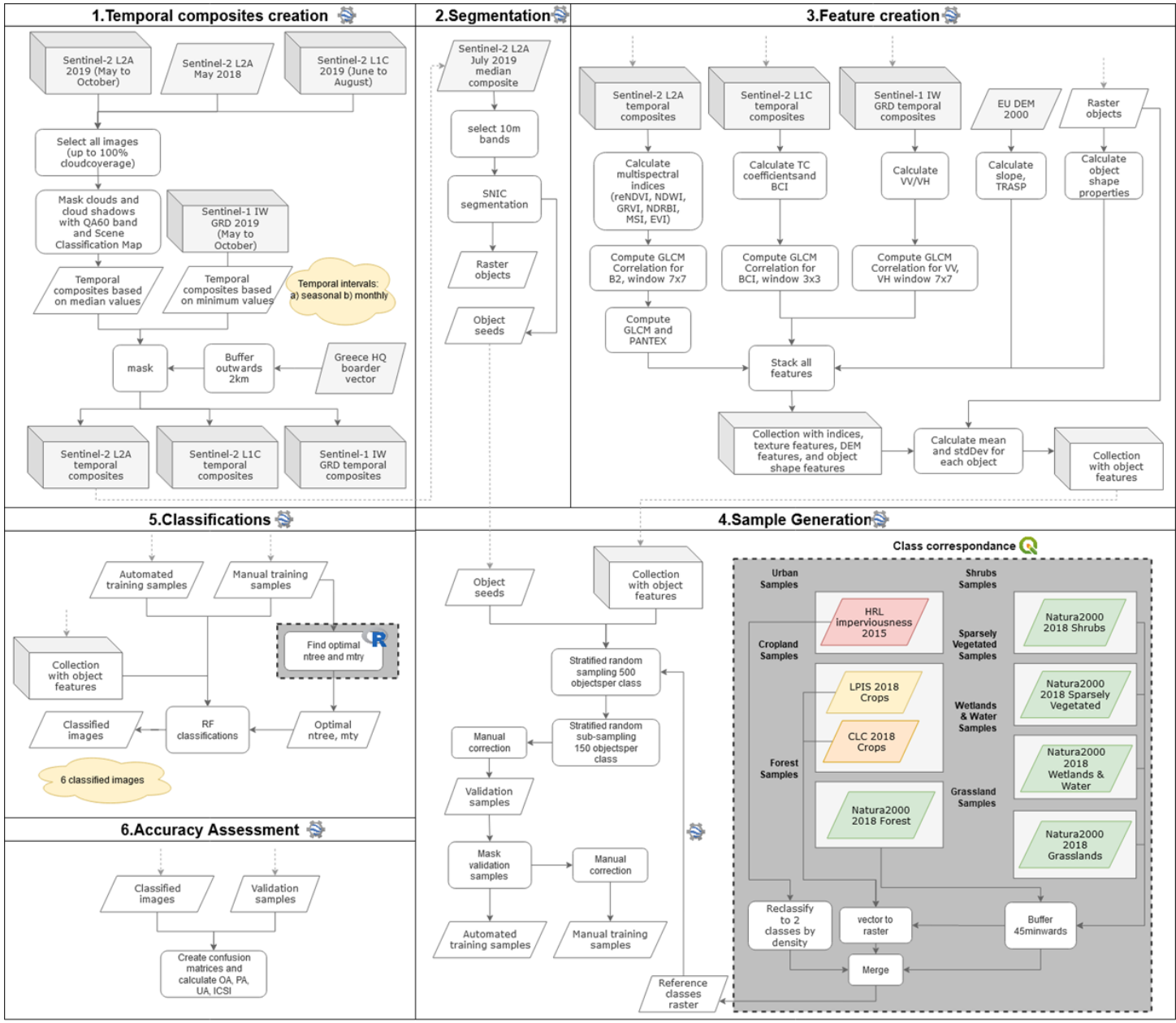


6 classifications:

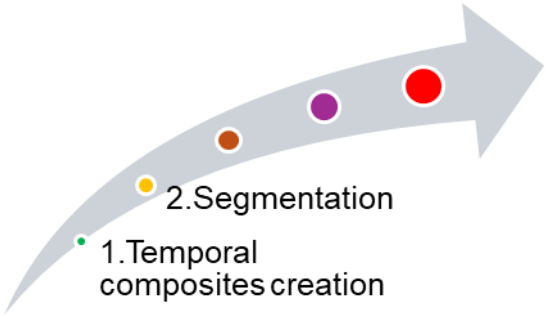
	Sampling Approach	Compositing	Feature Set	Number of Features	Abbreviation
1	Manual	Seasonal	Full	144	M-S-F
2	Manual	Seasonal	Reduced*	84	M-S-R
3	Manual	Monthly	Reduced*	168	M-M-R
4	Automated	Seasonal	Full	144	A-S-F
5	Automated	Seasonal	Reduced*	84	A-S-R
6	Automated	Monthly	Reduced*	168	A-M-R

*S2 L2A bands excluded

Methodology: Overall workflow



Methodology: Satellite data and preprocessing



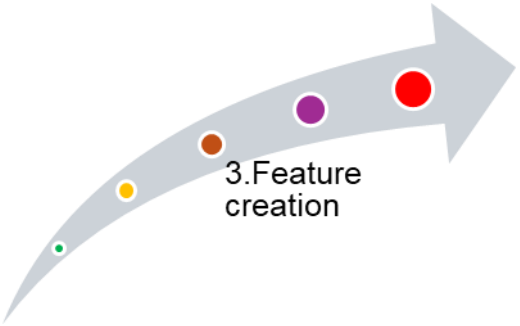
- ✓ GEE data catalogue

Data	Data range	Clouds, cirrus and shadows
S2 L2A	May - October 2019 + May 2018	sen2cor scene classification map
S2 L1C	June - August 2019	QA60 band & solar azimuth and zenith
S1 GRD σ_0 ascending and descending	May - October 2019	-

- Composite method: median

- Segmentation: Simple Non-Iterative Clustering (SNIC) on 10 m S2 L2A July composite (bands B2, B3, B4, B8)

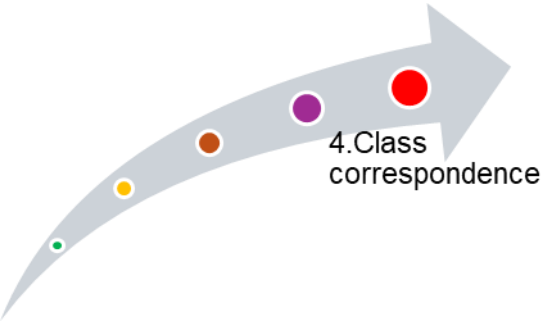
Methodology: Feature extraction



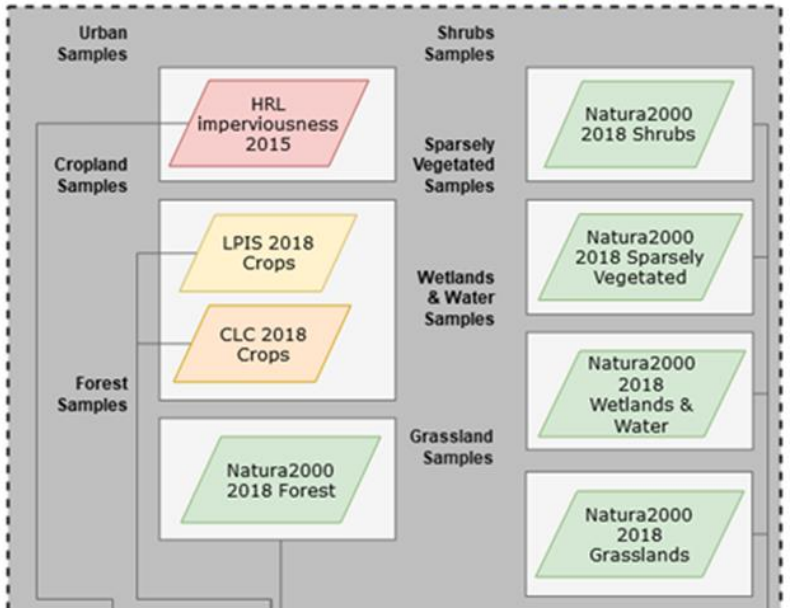
Feature Name	Statistic per Object	Brief Index Formula	Data Source
	Original Bands		
-B2, B3, B4, B5, B6, B7, B8, B8A, B11, B12	Mean, stdDev	-	S2 L2A
-VV, VH	Mean, stdDev	-	S1 IW GRD
	Spectral indices		
-reNDVI	Mean, stdDev	$\frac{B8 - B5}{B8 + B5}$	S2 L2A
-NDWI	Mean, stdDev	$\frac{B3 - B8}{B3 + B8}$	S2 L2A
-GRVI	Mean, stdDev	$\frac{B3 - B4}{B3 + B4}$	S2 L2A
-NDRBI	Mean, stdDev	$\frac{B4 - B2}{B4 + B2}$	S2 L2A
-MSI	Mean, stdDev	$\frac{B11}{B8}$	S2 L2A
-EVI	Mean, stdDev	$2.5\frac{B8 - B4}{B8 + 6B4 - 7.5B2 + 1}$	S2 L2A
-TC Brightness	Mean, stdDev		S2 L1C
-TC Greenness	Mean, stdDev		S2 L1C
-TC Wetness	Mean, stdDev		S2 L1C
-BCI	Mean, stdDev		S2 L1C
-VV/VH ratio	Mean, stdDev	$\frac{VV}{VH}$	S1 IW GRD
	Texture indices		
-B2 7 *x* 7 GLCM Correlation	Mean		S2 L2A
-PANTEX	Mean		S2 L2A
-BCI 3 *x* 3 GLCM Correlation	Mean		S2 L1C
-VV 7 *x* 7 GLCM Correlation	Mean		S1 IW GRD
VH 7 *x* 7 GLCM Correlation	Mean		S1 IW GRD

Feature Name	Statistic per Object	Brief Index Formula	Data Source
	Object shape properties		
-Perimeter, -Area			
-Form factor		$\frac{4\pi A}{P}$	
-Square pixel metric		$1 - \frac{4\sqrt{A}}{P}$	
-Fractal dimension		$2\frac{\ln(\frac{P}{4})}{\ln A}$	
-Shape index		$\frac{P}{4\sqrt{A}}$	
	Ancillary data		
-Elevation, -Slope, -TRASP	Mean		EU-DEM

Methodology: Classification scheme

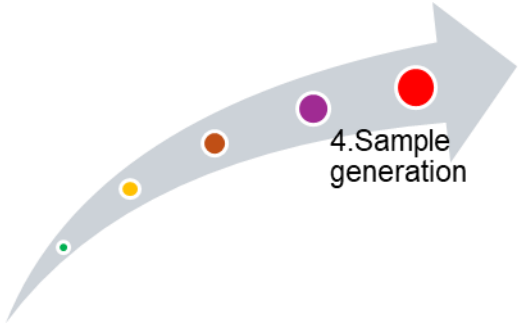


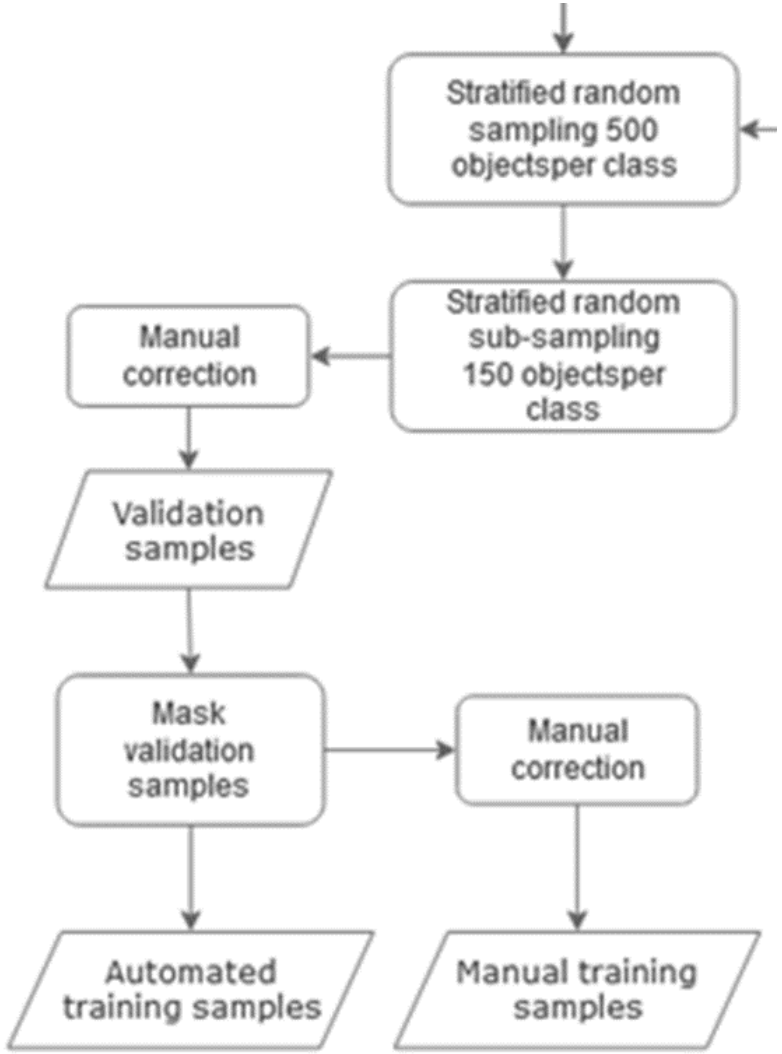
MAES Ecosystem Category (Level 1)	MAES Ecosystem Category (Level 2)	Ecosystem Types for Mapping and Assessment in Greece (Level 3)	Code	Data Source	Data Source Classes
Terrestrial	Urban	Dense to medium dense Urban Fabric (IM.D. 30–100%)	1.1.1	HRL	=> 30%
		Low density Urban Fabric (IM.D. 0–30%)	1.1.2	HRL	<30%
	Cropland	Arable land	2.1.1	LPIS, CLC	LPIS: 40, CLC: 2.1
		Permanent crops	2.2.1	LPIS, CLC	LPIS: 50, 60, 70, CLC: 2.2
	Woodland and forest	Temperate deciduous forests	3.1.1	N2K	9110, 9130, 9140, 9150, 9180, G91K, G91L
		Mediterranean deciduous forests	3.1.2	N2K	91M0, 9280, 9250, 9310, 9350, 9260, 925A
		Floodplain forests (Riparian forest/Fluvial forest)	3.2.1	N2K	92A0, 92C0, 92D0, 91E0, 91F0
		Temperate mountainous coniferous forests	3.3.1	N2K	9530, 951B, 91BA, 91CA, 95A0, 9410
		Mediterranean coniferous forests	3.3.2	N2K	2270, 9540, 9560, 9290
		Mediterranean sclerophyllous forests	3.4.1	N2K	9340, 934A, 9320, 9370
		Mixed Forest	3.5.1	N2K	9270
	Grassland	Grasslands	4.1.1	N2K	6110, 6170, 6220, 6230, G628, 6290, 62A0, 62D0, 6420, 6430, G645, 6510, 651A, 1070
	Heathland and shrub	Moors and heathland	5.1.1	N2K	4060, 4090, 5360, 5420, 5430
		Sclerophyllous vegetation	5.2.1	N2K	2250, 5110, 5150, 5160, 5210, 5230, 5310, 5330, 5340, 5350
	Sparsely vegetated	Sparsely vegetated areas	6.1.1	N2K	8130, 8140, 8210, 8220, 8230, 8310, 8320, 8330, 2240, 2260, 9620, 8250
		Beaches, dunes, sands	6.2.1	N2K	1210, 1240, 1410, 2110, 2120, 2220, 2230, 2210, 21B0
		Bare rocks, burnt areas, mines, dump, land without current use	6.3.1	N2K	1030
	Wetlands	Inland freshwater and saline marshes	7.1.1	N2K	72A0, 72B0, 2190, 1310, 1410, 1420, 1430, 1510, 1440
		Peat bogs	7.2.1	N2K	7140, 7210, 7220, 7230
Marine	Marine	Marine	7.3.1	N2K	1110, 1120, 1130, 1150, 1160, 1170, 1180, 1310
Freshwater	Rivers and lakes	Rivers and lakes	8.1.1	N2K	3130, 3140, 3150, 3170, 3240, 3250, 3260, 3280, 3290, 3190



It was challenging to harmonize the ecologically- interpreted classes with the LULC classification schemes of different reference data sets.

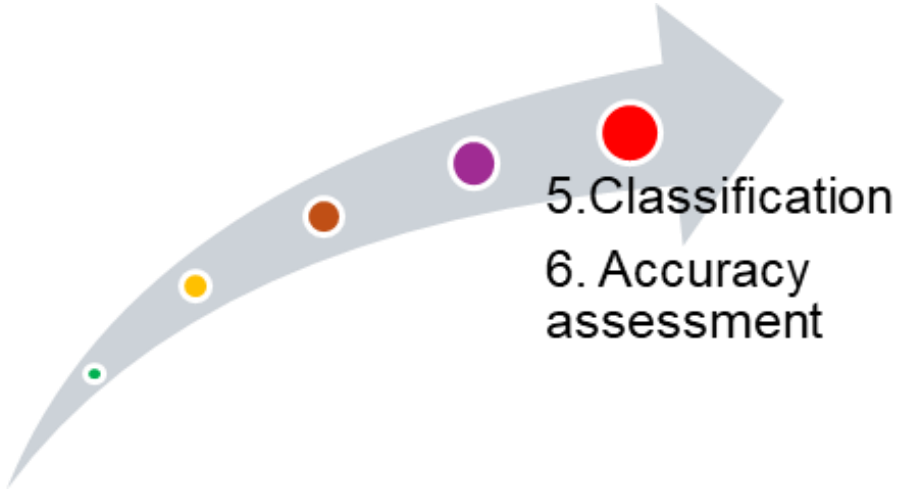
Methodology: Reference data





manual sampling approach
=
manually correcting automated samples

Methodology: Classification and accuracy assessment



- Random Forests
- confusion matrix & derived standard accuracy measures
  - OA
  - PA
  - UA
  - Individual Classification Success Index (ICSI)

$$ICSI = UA\%_i + PA\%_i - 100$$

Ecosystem type map of Greece outside Natura 2000 SACs

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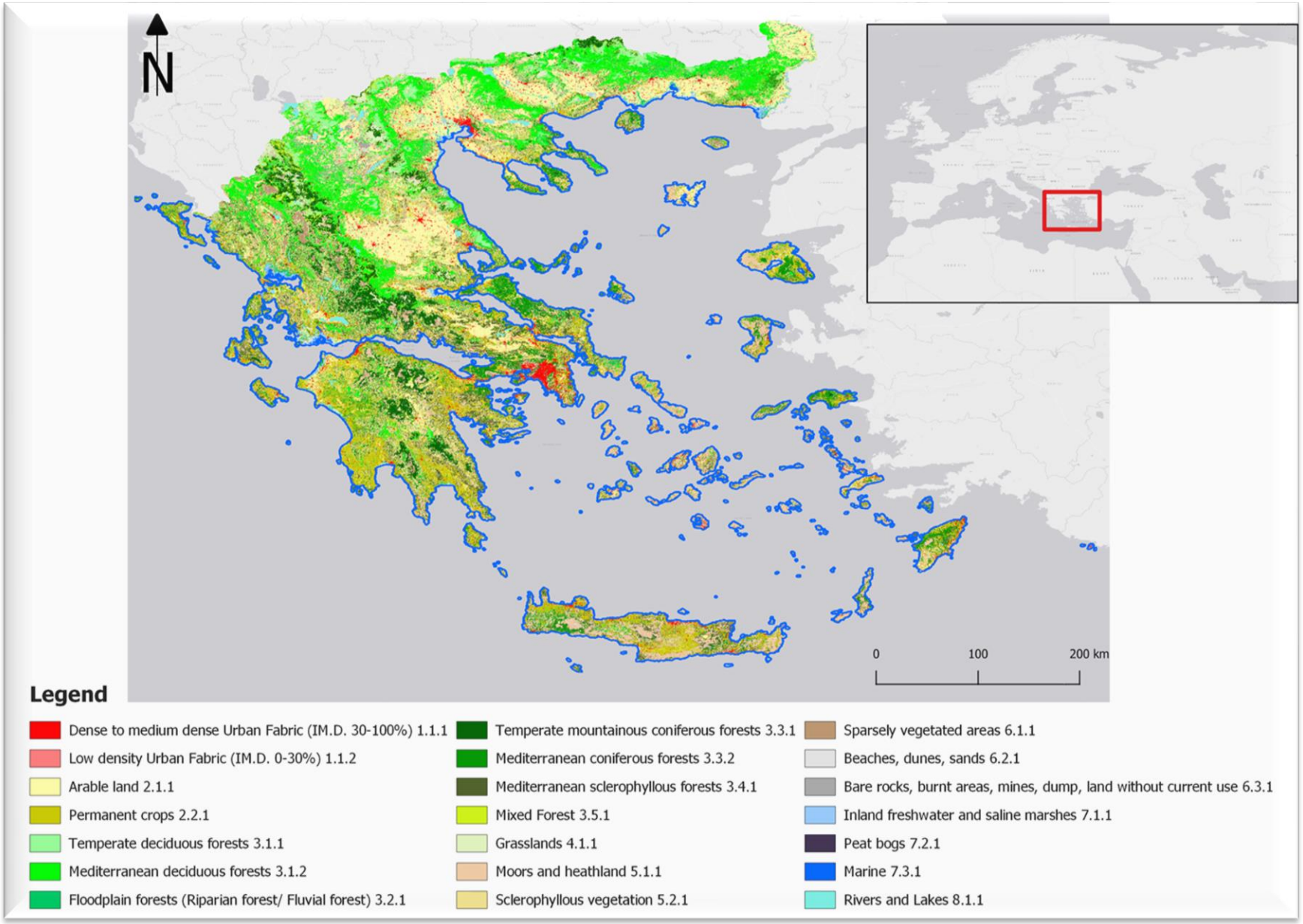
Results



Results - Accuracy

	M-S-F			M-S-R			M-M-R			A-S-F			A-S-R			A-M-R		
Class	PA	UA	ICSI	PA	UA	ICSI	PA	UA	ICSI	PA	UA	ICSI	PA	UA	ICSI	PA	UA	ICSI
1.1.1	84	83	67	82	84	66	82	85	67	96	60	56	96	59	55	96	59	55
1.1.2	93	80	73	93	81	74	93	83	76	45	92	37	43	92	35	43	92	35
2.1.1	90	87	77	89	86	75	91	88	79	91	79	70	91	78	69	93	80	73
2.2.1	80	81	61	84	85	69	84	86	70	83	74	57	84	73	57	86	78	64
3.1.1	85	82	67	86	81	67	91	84	75	89	74	63	87	74	61	90	81	71
3.1.2	77	79	56	75	79	54	79	78	57	80	66	46	79	66	45	80	65	45
3.2.1	68	64	32	72	60	32	74	81	55	65	73	38	68	73	41	67	75	42
3.3.1	82	77	59	84	77	61	83	76	59	81	85	66	79	82	61	79	83	62
3.3.2	81	74	55	84	79	63	84	79	63	85	74	59	85	78	63	83	79	62
3.4.1	37	62	−1	43	67	10	48	68	16	55	63	18	57	61	18	57	60	17
3.5.1	58	78	36	63	80	43	60	78	38	58	72	30	57	71	28	69	76	45
4.1.1	75	75	50	76	76	52	77	75	52	78	75	53	78	76	54	79	75	54
5.1.1	48	61	9	49	63	12	51	62	13	52	51	3	55	52	7	55	56	11
5.2.1	46	39	−15	49	44	−7	46	44	−10	48	55	3	48	54	2	49	53	2
6.1.1	87	72	59	88	73	61	90	75	65	84	78	62	83	78	61	86	78	64
6.2.1	62	76	38	69	75	44	71	77	48	69	65	34	70	63	33	70	62	32
6.3.1	90	83	73	91	84	75	88	82	70	38	92	30	36	97	33	35	96	31
7.1.1	81	76	57	78	76	54	89	82	71	87	85	72	86	85	71	88	86	74
7.2.1	81	100	81	78	100	78	81	100	81	66	100	66	66	100	66	63	100	63
7.3.1	98	99	97	97	99	96	97	99	96	98	100	98	99	100	99	97	100	97
8.1.1	93	98	91	95	98	93	95	98	93	97	98	95	95	99	94	96	99	95
OA		77.33			78.67			79.55			74.89			74.61			75.64	

	Sampling Approach	Compositing	Feature Set	Number of Features	Abbreviation
1	Manual	Seasonal	Full	144	M-S-F
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4	Automated	Seasonal	Full	144	A-S-F
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6	Automated	Monthly	Reduced*	168	A-M-R

*S2 L2A bands excluded

Results - Accuracy

	M-S-F			M-S-R			M-M-R			A-S-F			A-S-R			A-M-R		
Class	PA	UA	ICSI	PA	UA	ICSI	PA	UA	ICSI	PA	UA	ICSI	PA	UA	ICSI	PA	UA	ICSI
1.1.1	84	83	67	82	84	66	82	85	67	96	60	56	96	59	55	96	59	55
1.1.2	93	80	73	93	81	74	93	83	76	45	92	37	43	92	35	43	92	35
2.1.1	90	87	77	89	86	75	91	88	79	91	79	70	91	78	69	93	80	73
2.2.1	80	81	61	84	85	69	84	86	70	83	74	57	84	73	57	86	78	64
3.1.1	85	82	67	86	81	67	91	84	75	89	74	63	87	74	61	90	81	71
3.1.2	77	79	56	75	79	54	79	78	57	80	66	46	79	66	45	80	65	45
3.2.1	68	64	32	72	60	32	74	81	55	65	73	38	68	73	41	67	75	42
3.3.1	82	77	59	84	77	61	83	76	59	81	85	66	79	82	61	79	83	62
3.3.2	81	74	55	84	79	63	84	79	63	85	74	59	85	78	63	83	79	62
3.4.1	37	62	−1	43	67	10	48	68	16	55	63	18	57	61	18	57	60	17
3.5.1	58	78	36	63	80	43	60	78	38	58	72	30	57	71	28	69	76	45
4.1.1	75	75	50	76	76	52	77	75	52	78	75	53	78	76	54	79	75	54
5.1.1	48	61	9	49	63	12	51	62	13	52	51	3	55	52	7	55	56	11
5.2.1	46	39	−15	49	44	−7	46	44	−10	48	55	3	48	54	2	49	53	2
6.1.1	87	72	59	88	73	61	90	75	65	84	78	62	83	78	61	86	78	64
6.2.1	62	76	38	69	75	44	71	77	48	69	65	34	70	63	33	70	62	32
6.3.1	90	83	73	91	84	75	88	82	70	38	92	30	36	97	33	35	96	31
7.1.1	81	76	57	78	76	54	89	82	71	87	85	72	86	85	71	88	86	74
7.2.1	81	100	81	78	100	78	81	100	81	66	100	66	66	100	66	63	100	63
7.3.1	98	99	97	97	99	96	97	99	96	98	100	98	99	100	99	97	100	97
8.1.1	93	98	91	95	98	93	95	98	93	97	98	95	95	99	94	96	99	95
OA		77.33			78.67			79.55			74.89			74.61			75.64	

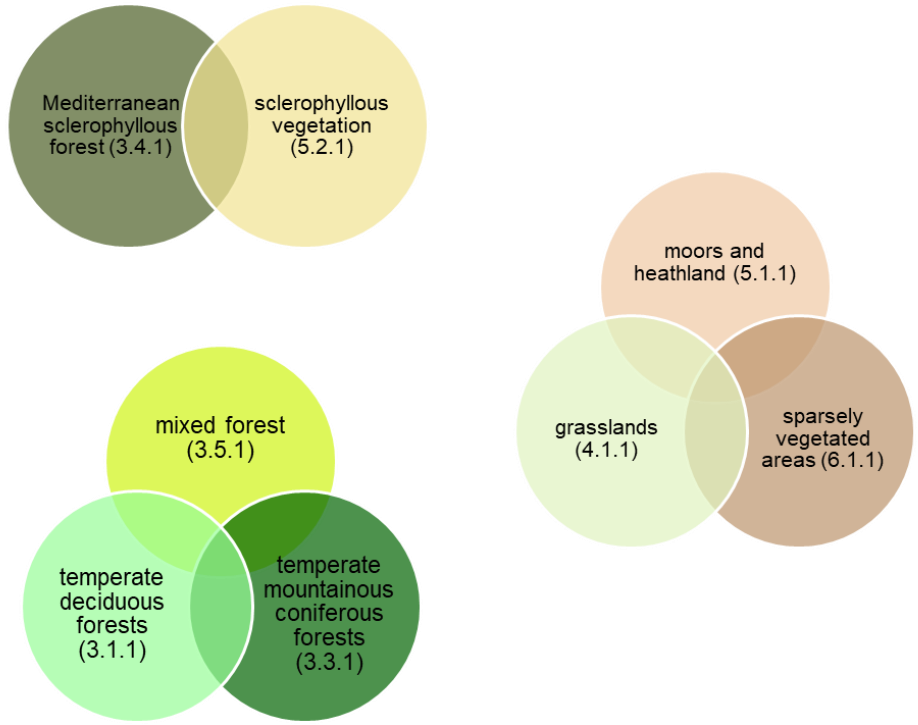
- monthly instead of seasonal improved 13 classes
- low accuracies for 5.x.x and 3.4.1 in all classifications

Results - Confusion matrix

- ✓ Confusion matrix for best performing classification (M-M-R)

Reference \ Classification	1.1.1	1.1.2	2.1.1	2.2.1	3.1.1	3.1.2	3.2.1	3.3.1	3.3.2	3.4.1	3.5.1	4.1.1	5.1.1	5.2.1	6.1.1	6.2.1	6.3.1	7.1.1	7.2.1	7.3.1	8.1.1
1.1.1	82	10		1												1	6				
1.1.2	5	93				1	1									1					
2.1.1	1	1	91	1		1	1					1				2	1	1			
2.2.1		1	3	84		1	2		2	3				3							
3.1.1					91	5		1		1	1	1			1						
3.1.2				1	7	79	2	1		3	3	1	1	3							
3.2.1	2	2	3	1		1	74							2		2		13			
3.3.1		1						83	5	1	6	1		3							
3.3.2			1	1		1		3	84	2			1	5	2						
3.4.1		1	1	4		1	2	4	7	48			6	27			1				
3.5.1					14			21			60	1		4							
4.1.1			1	1		3						77	6	2	10	1					
5.1.1		1	3	1	1	1			1	1		14	51	4	14		8				
5.2.1			1	1		8	1	5	6	13	1	3	7	46	6		1				
6.1.1								1				3	5		90		1				1
6.2.1		1					5									71	2	22			
6.3.1	6	1											2		1	1	88	1			
7.1.1							2						1	1		5	1	89			
7.2.1							3					13						3	81		
7.3.1																		3		97	
8.1.1							1											5			95

- ✓ in all classifications, confusion between:

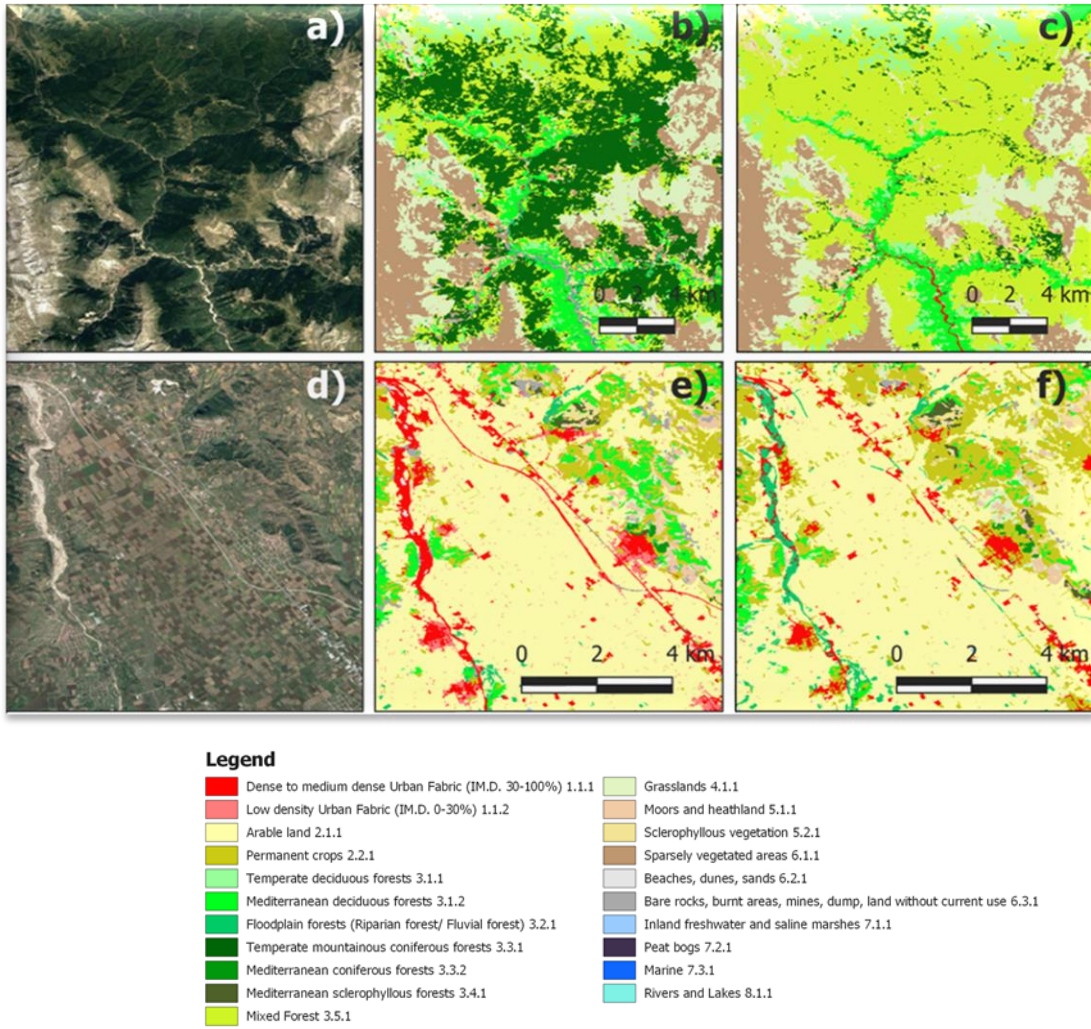


Results - Visual assessment

✓ Confusion matrix for best performing classification (M-M-R)

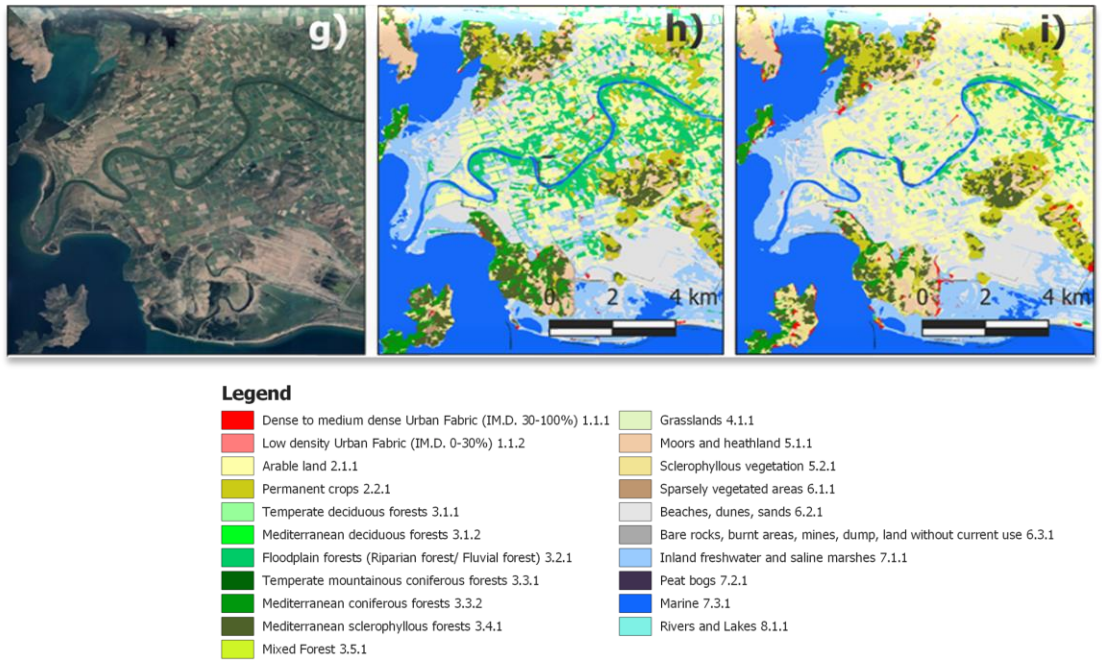
- minor differences between different feature sets
- considerable differences between different sampling techniques

<u>automated sampling:</u>
overestimation of mixed forests (5.3.1) and Mediterranean coniferous forests (3.3.2), underestimation of low density urban fabric (1.1.2)

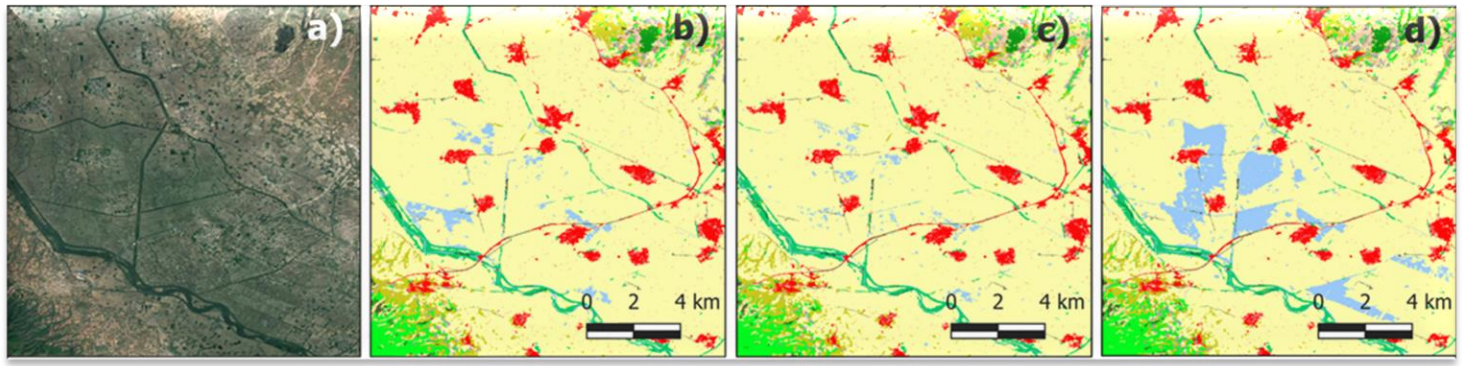


Results - Visual assessment

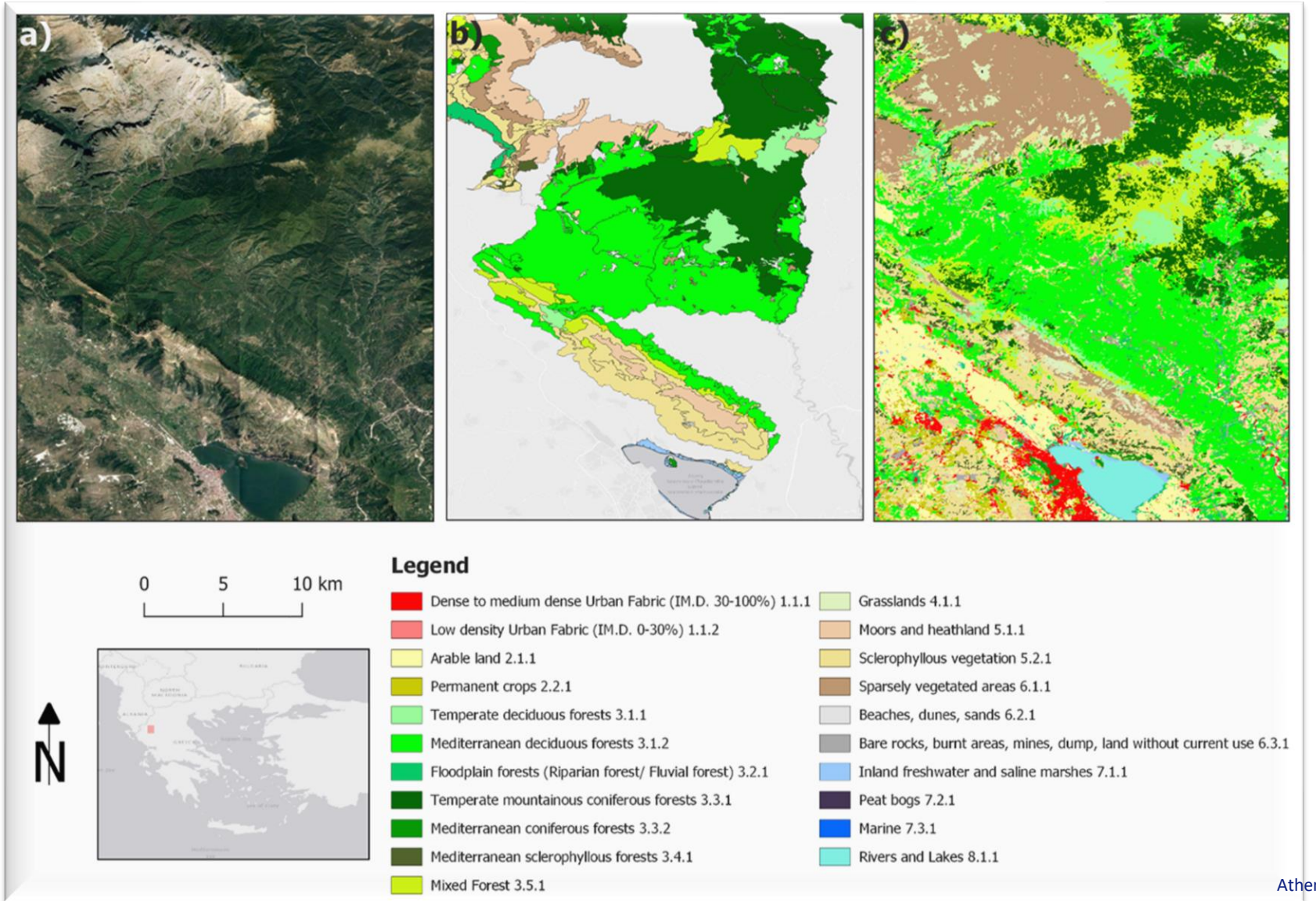
manual sampling:
arable land (2.1.1) was frequently classified as floodplain forests (3.2.1)



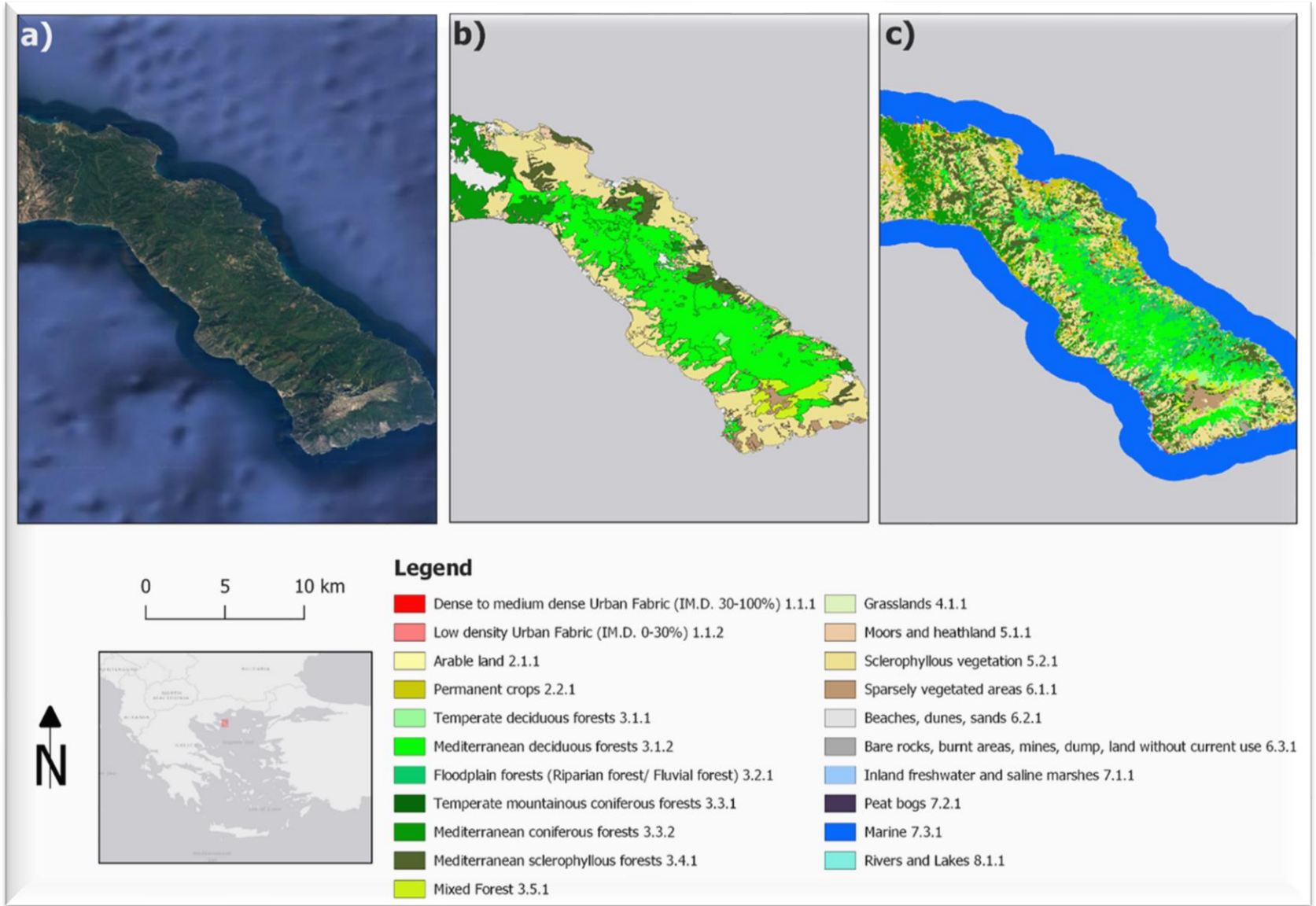
monthly features instead of seasonal created errors in high-moisture agriculture areas



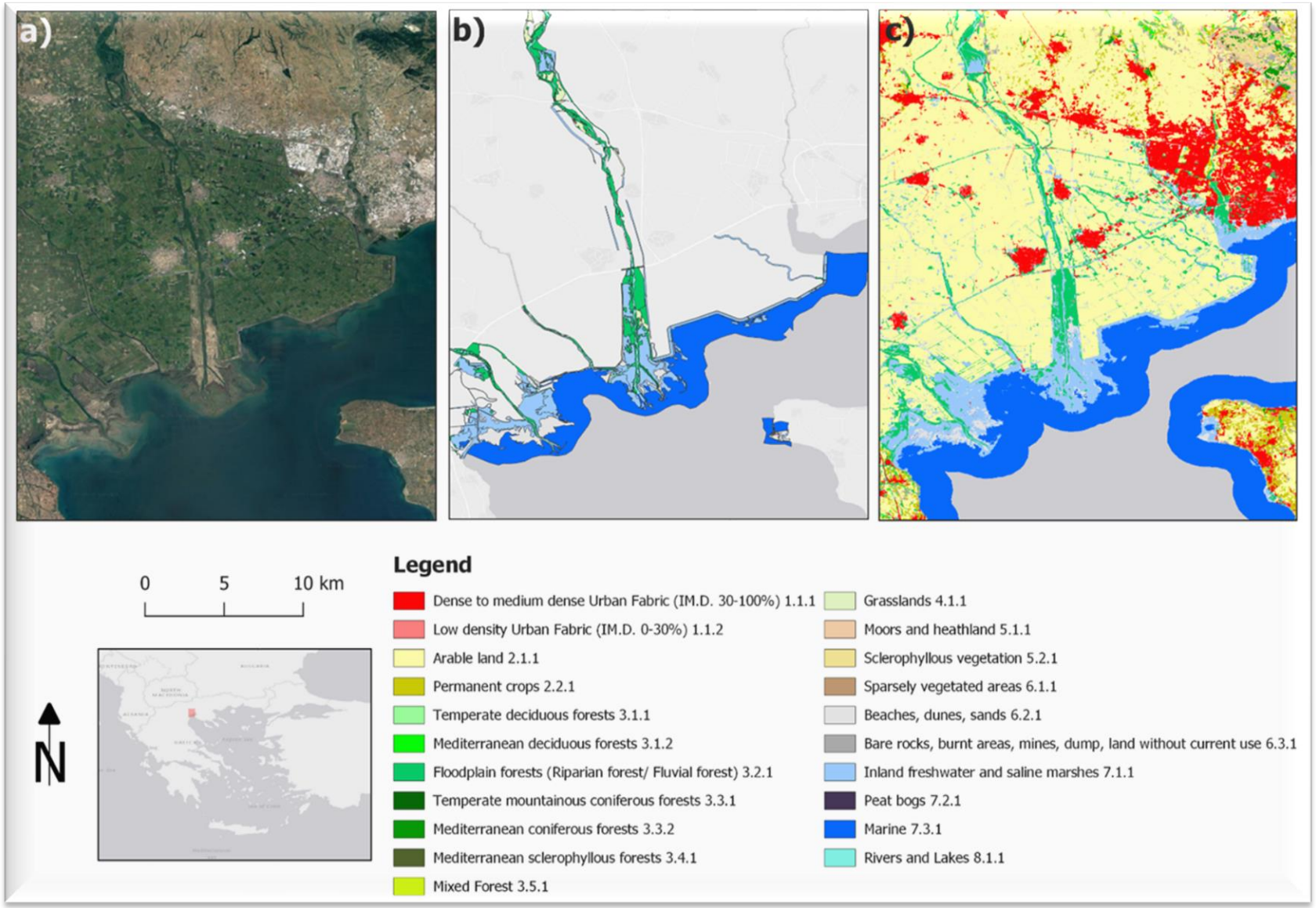
Results - Visual assessment



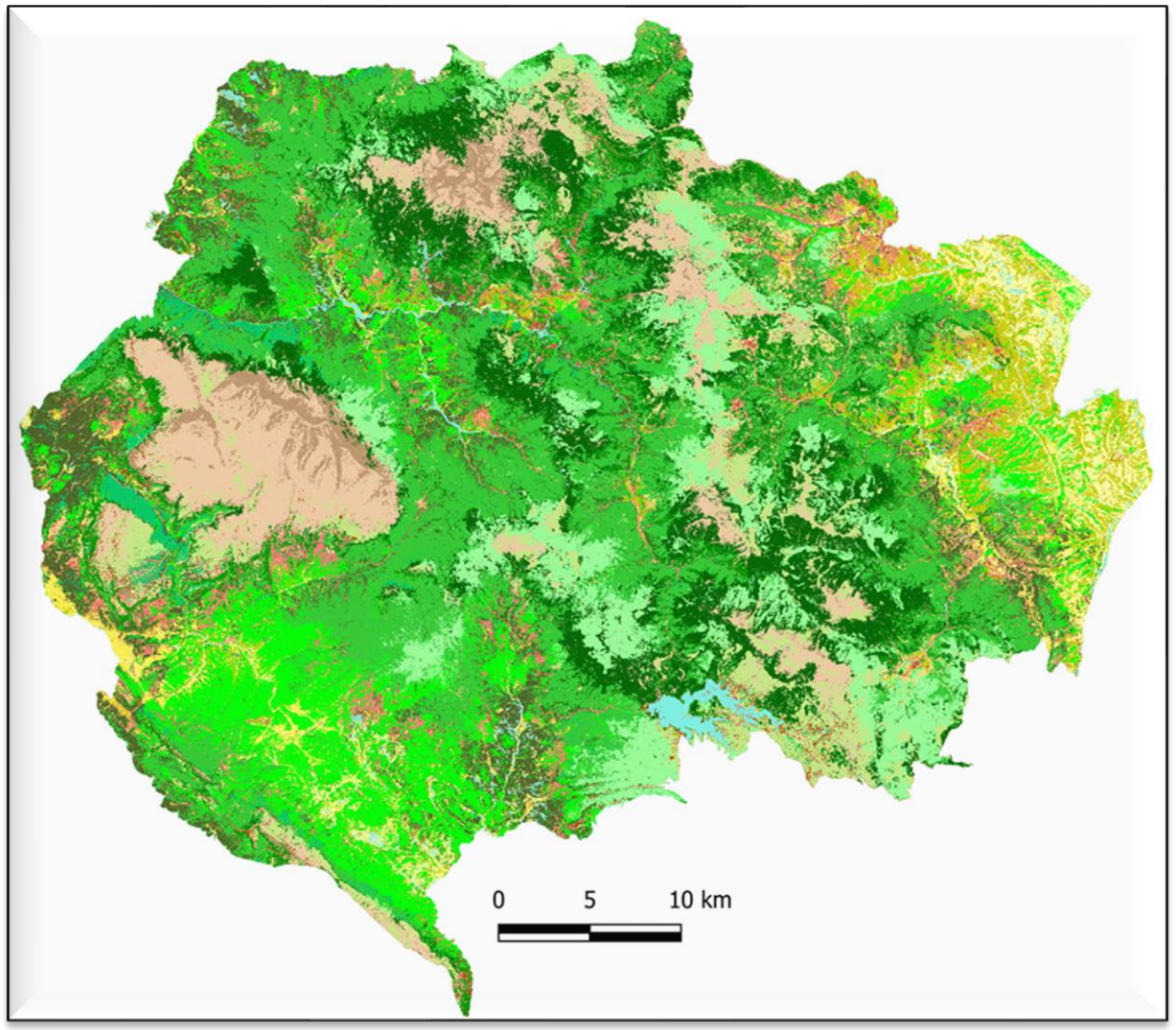
Results - Visual assessment



Results - Visual assessment



Results - Visual assessment

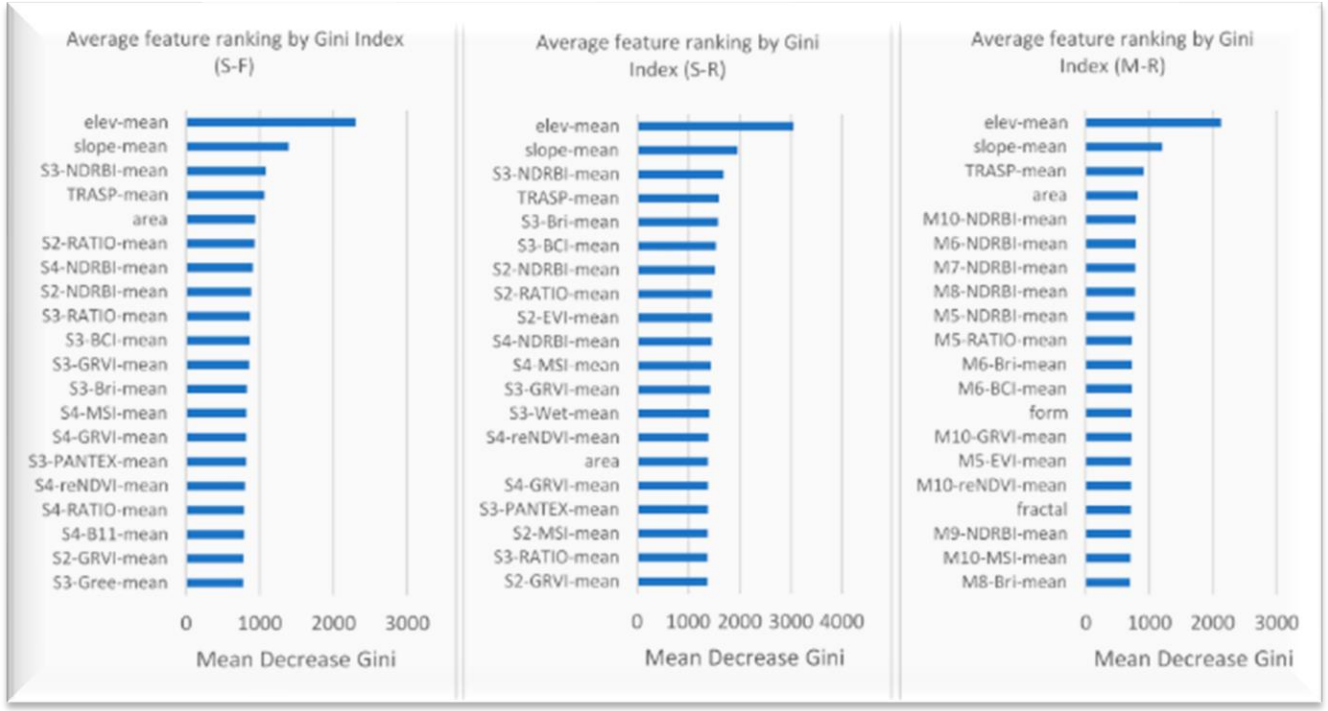


- Low density Urban Fabric (IM.D. 0-30%) 1.1.2
- Arable land 2.1
- Permanent crops 2.2
- Heterogeneous agricultural areas 2.3
- Temperate deciduous forests
- Mediterranean deciduous forests
- Floodplain forests (Riparian forest/ Fluvial forest)
- Temperate mountainous coniferous forests
- Mediterranean coniferous forests
- Mediterranean sclerophyllous forests
- Mixed Forest
- Natural grasslands with trees and scrubs (T.C.D. > 30%)
- Moors and heathland 5.1.1
- Sclerophyllous vegetation 5.2.1
- Sparsely vegetated areas 6.1.1
- Mines, dump, land without current use 6.4.1
- Rivers and Lakes

Results - Variable importance

✓ Most important variables

- topographic features → elevation, slope, TRASP
- object properties → area, form factor, fractal
  - SAR VV/VH ratio
    - only SWIR (B11) S2 spectral bands



Discussion

First national scale LC mapping
- ✓complex classification scheme
- ✓ecological-relevant classes

OBIA:
- ✓accounts for geolocation offset
- ✓accounts for cloud masking errors
- ✓exploitation of object properties

RF:
- ✓ability to handle highly correlated multidimensional data

Lower accuracies in classes covering different ecosystem types but similar spectral responses → ecological modeling needed

Contribution
- end-to-end automated workflow, for annual LC mapping in Greece
- ecosystem condition and ES mapping and assessment
- roadmap for the further development

Key findings
- EO data alone are not adequate for predicting and mapping the complex Mediterranean landscape
- automated sampling not so efficient in complex and ecological-relevant classification schemes

Published paper & code

https://doi.org/10.3390/rs12203303

https://github.com/n-verde/LIFE-IP_4_NATURA

remote sensing

MDPI

Article

National Scale Land Cover Classification for Ecosystem Services Mapping and Assessment, Using Multitemporal Copernicus EO Data and Google Earth Engine

Natalia Verde [1,2], Ioannis P. Kokkoris [3], Charalampos Georgiadis [1], Dimitris Kaimaris [1], Panayotis Dimopoulos [3], Ioannis Mitsopoulos [4] and Giorgos Mallinis [1,2,*]

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2 Forest Remote Sensing and Geospatial Analysis Laboratory, Democritus University of Thrace, 68200 Orestiada, Greece
3 Department of Biology, Laboratory of Botany, University of Patras, 26504 Patras, Greece; ipkokkoris@upatras.gr (I.P.K.); pdimopoulos@upatras.gr (P.D.)
4 Ministry of Environment & Energy, Directorate of Biodiversity and Natural Environment Management, 11526 Athens, Greece; i.mitsopoulos@prv.ypeka.gr
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check for updates

Abstract: Land-Use/Land-Cover (LULC) products are a common source of information and a key input for spatially explicit models of ecosystem service (ES) supply and demand. Global, continental, and regional, readily available, and free land-cover products generated through Earth Observation (EO) data, can be potentially used as relevant to ES mapping and assessment processes from regional to national scales. However, several limitations exist in these products, highlighting the need for timely land-cover extraction on demand, that could replace or complement existing products. This study focuses on the development of a classification workflow for fine-scale, object-based land cover mapping, employed on terrestrial ES mapping, within the Greek terrestrial territory. The processing was implemented in the Google Earth Engine cloud computing environment using 10 m spatial resolution Sentinel-1 and Sentinel-2 data. Furthermore, the relevance of different training data extraction strategies and temporal EO information for increasing the classification accuracy was also evaluated. The different classification schemes demonstrated differences in overall accuracy ranging from 0.88% to 4.94% with the most accurate classification scheme being the manual sampling/monthly feature classification achieving a 79.55% overall accuracy. The classification results suggest that existing LULC data must be cautiously considered for automated extraction of training samples, in the case of new supervised land cover classifications aiming also to discern complex vegetation classes. The code used in this study is available on GitHub and runs on the Google Earth Engine web platform.

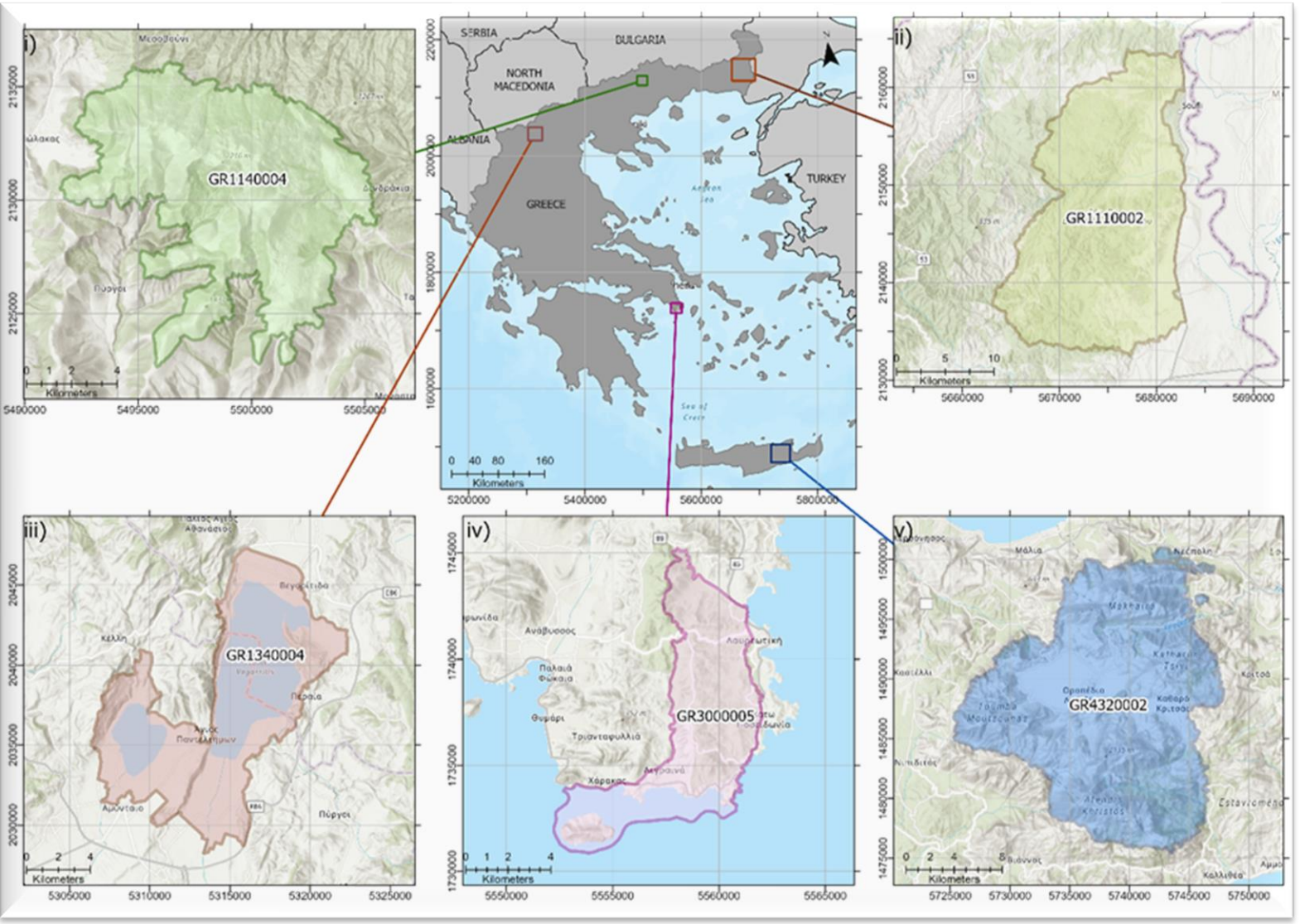
Keywords: remote sensing; seasonal; Random Forests; OBIA; machine learning; big data; multispectral; radar; GEE; object

Εδώ ζούμε
Natura 2000

Ecosystem type maps at local (case study) scale / large scale

Ecosystem type maps at local (case study) scale / large scale

Pilot areas



- ✓ GR1140004 Koryfes Orous Falakro
- ✓ GR1110002 Dasos Dadias – Soufli
- ✓ GR1340004 Limnes Vegoritida – Petron
- ✓ GR 4320002 Dikti
- ✓ GR 3000005 Sounio

Ecosystem type maps at local (case study) scale / large scale

Workflow

Data set

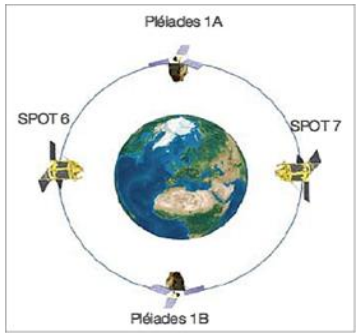
EU-DEM, CLC, N2K

Copernicus Europe's eyes on Earth

sentinel-2

planet.

HELLENIC CADASTRE



Training Sample
(N2K, habitat map Natura 2000)

Validation Sample
(N2K, Google Earth, VHR)

Visual interpretation
(historical orthophotos)
GIS

eCognition

OBIA

Random Forest

- MAES Ecosystem types (level 2)
- Spectral Bands & Indices, Elevation, Slope, TRASP

Accuracy Assessment

Ecosystem types maps
1945, 1996, 2007, 2022

Data inputs

Geospatial data

- ✓ European Digital Elevation Model, EU-DEM
- ✓ CORINE Land Cover (CLC)
- ✓ Natura 2000 (N2K)
- ✓ Habitat map of Natura 2000 terrestrial areas (National Cadastre and Mapping Agency) (1:5000)

Satellite data

✓ Sentinel 2 L2A	August 2022	10m
✓ PlanetScope	August 2022	3m

Historical orthophotos

✓ Orthophotos	1945	1m
✓ Orthophotos	1996-1998	1m
✓ Large Scale Orthophotos	2007	0,5m

Classification Scheme

- ✓ 11 classes based on MAES-Level 2 ecosystem types

Urban	Cropland	Grassland
Sparsely vegetated land	Woodland and Forest	Heathland and shrub
Wetlands	Rivers and lakes	Mines
Burned areas		Burned areas Moderate severity

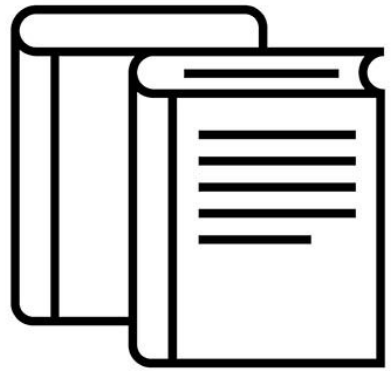
Reference Data

Training Sample

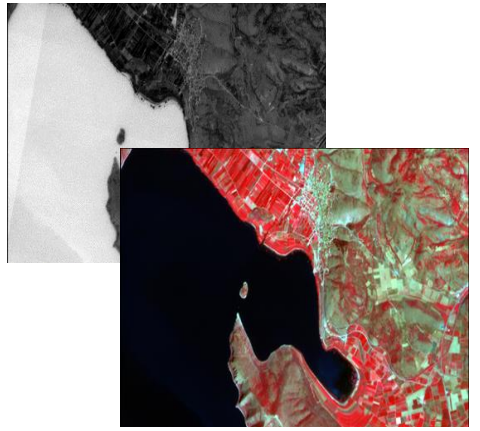
- ✓ Natura 2000 (N2K)
- ✓ Habitat map of Natura 2000 by the National Cadastre and Mapping Agency (1:5000)

Validation Sample

- ✓ Google Earth
- ✓ VHR IMAGE 2018



Feature Extraction



Spectral Bands

- ✓ Blue
- ✓ Green
- ✓ Red
- ✓ Near Infrared - NIR

Spectral indexes

- ✓ NDVI
- ✓ NDWI
- ✓ NDSI

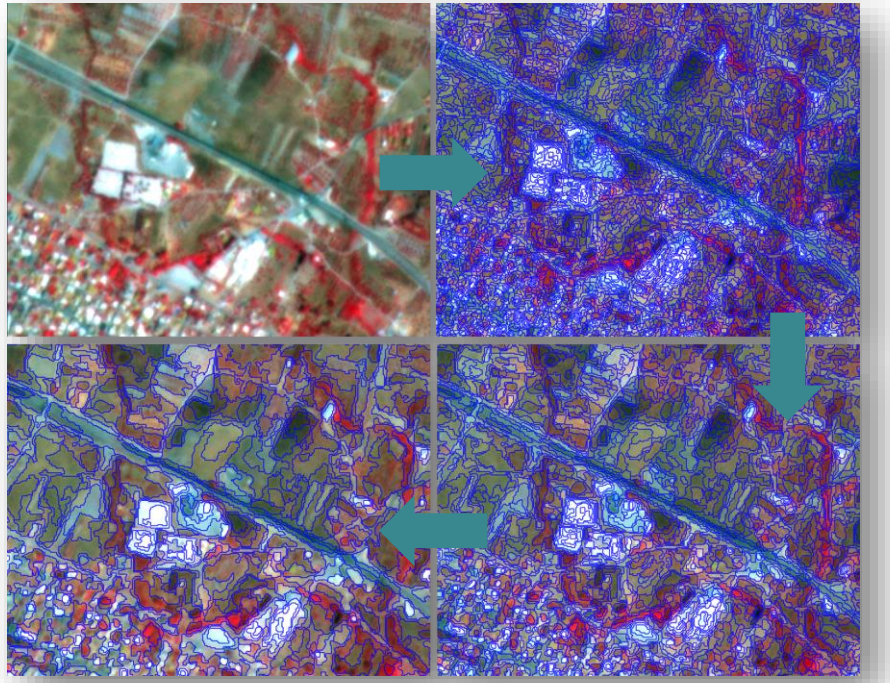
Topography

- ✓ Elevation
- ✓ Slope
- ✓ TRASP

Classification

- ✓ Object Based Image Analysis-OBIA

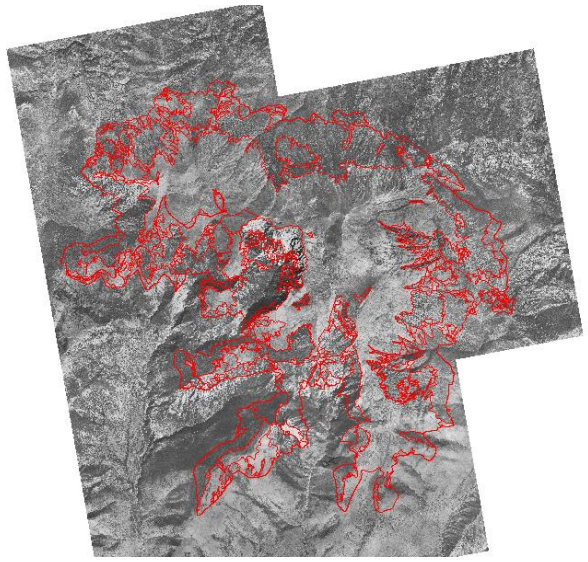
Segmentation level	Scale parameter	Shape criterion	Compactness criterion	Image Layer weights
1	20	0,1	0,5	1,1,1,1
2	40	0,1	0,5	1,1,1,1
3	80	0,1	0,5	1,1,1,1



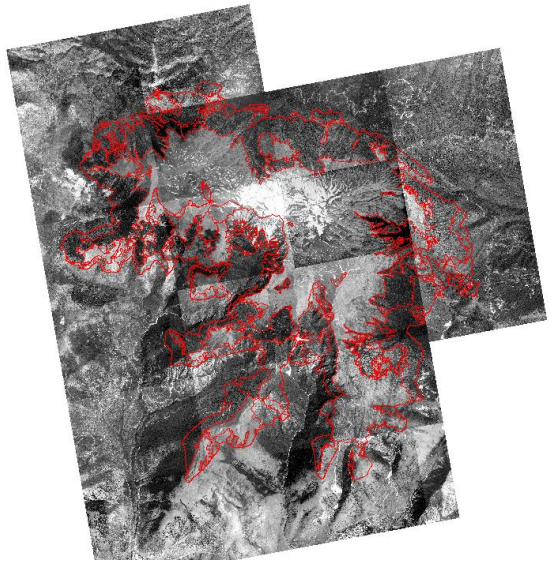
- ✓ Random Forest algorithm

Visual Image Interpretation

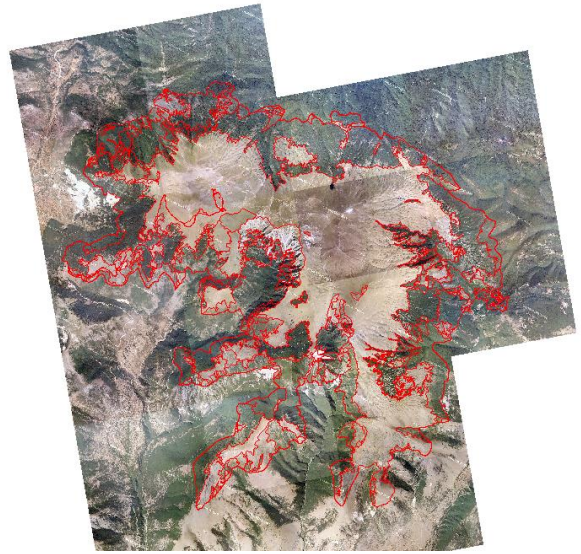
- ✓ Air photos 1945 -1996 : Manual interpretation on screen digitising
- ✓ Air imagery 2007: Manual interpretation on screen digitising



1945



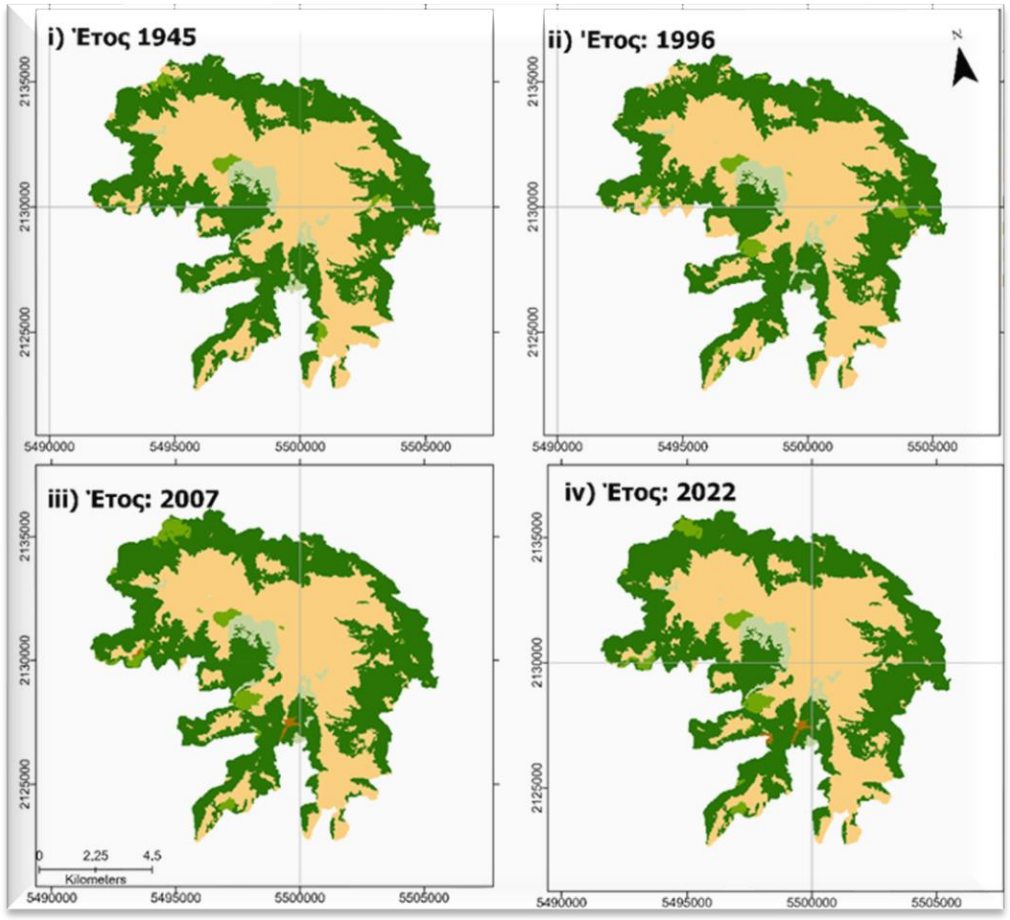
1996



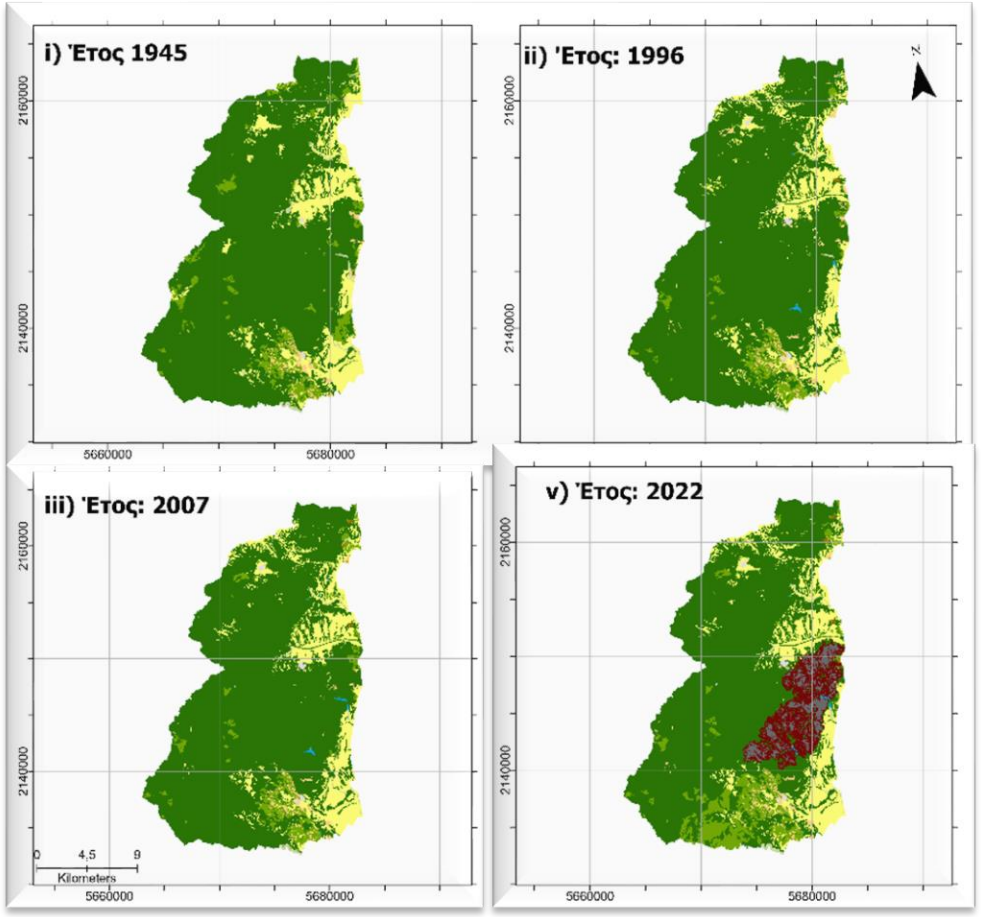
2007

Ecosystem types maps

✓ GR1140004

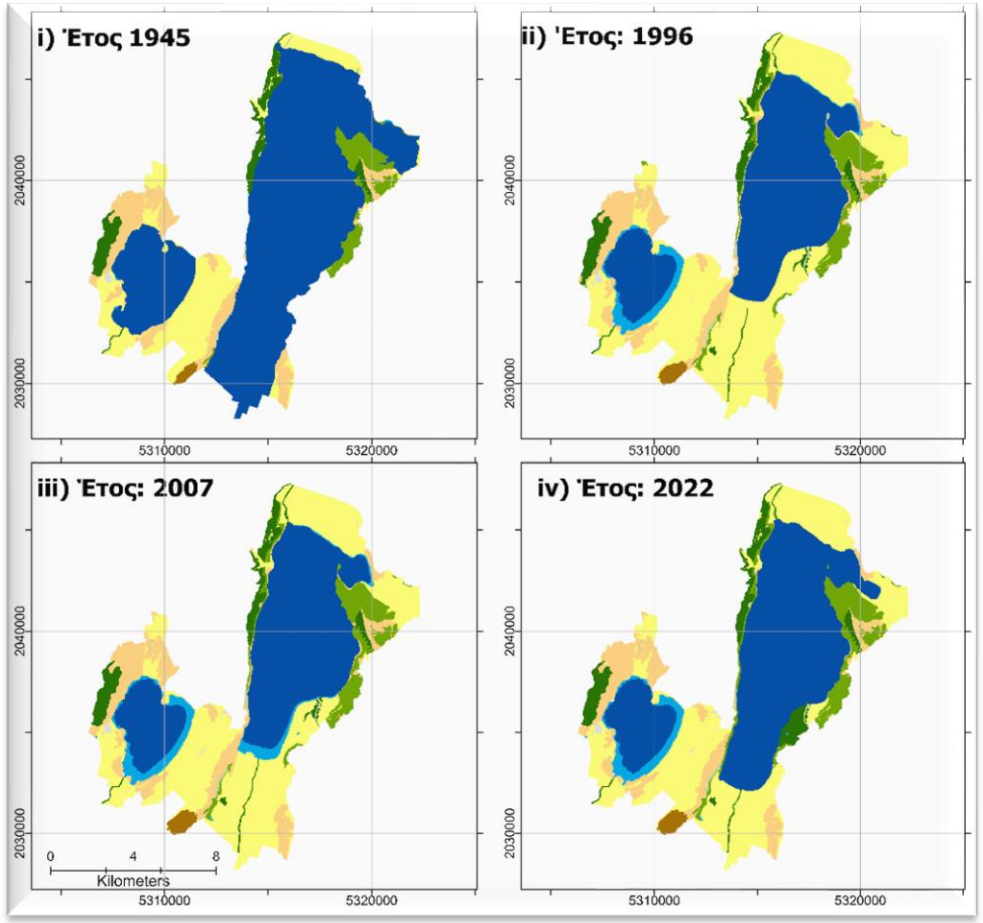


✓ GR1110002

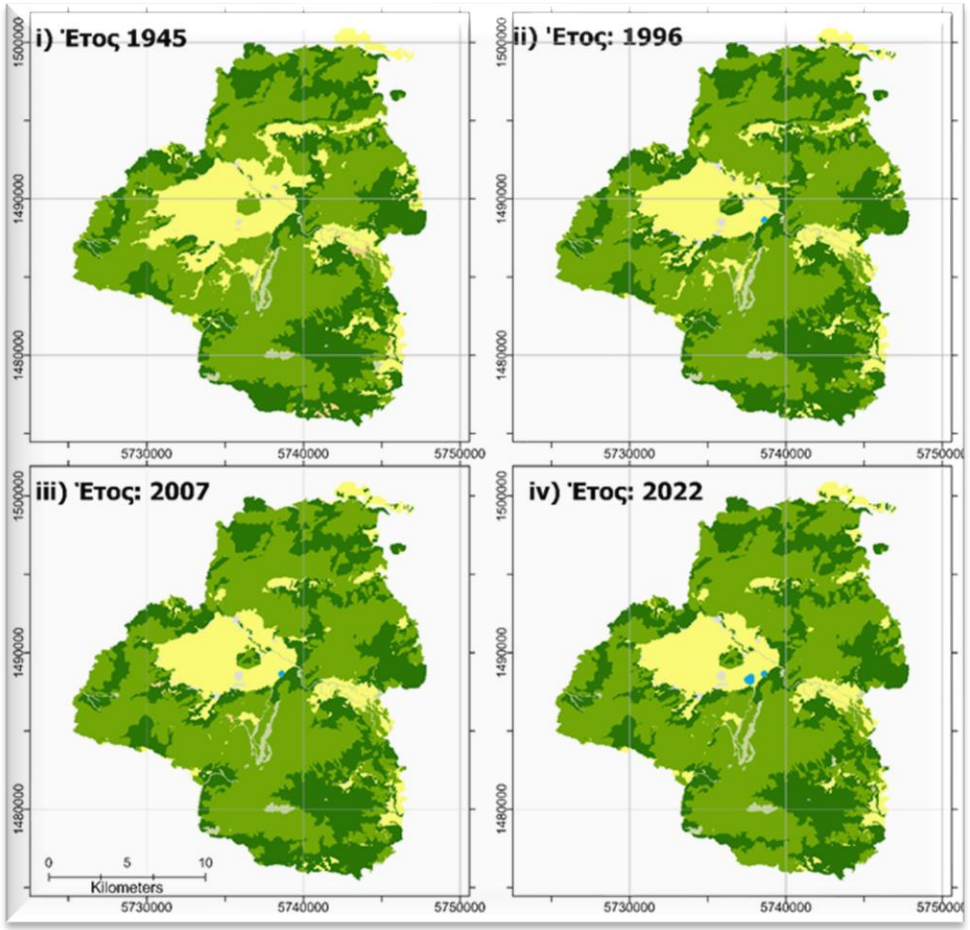


Ecosystem types maps

✓ GR1340004

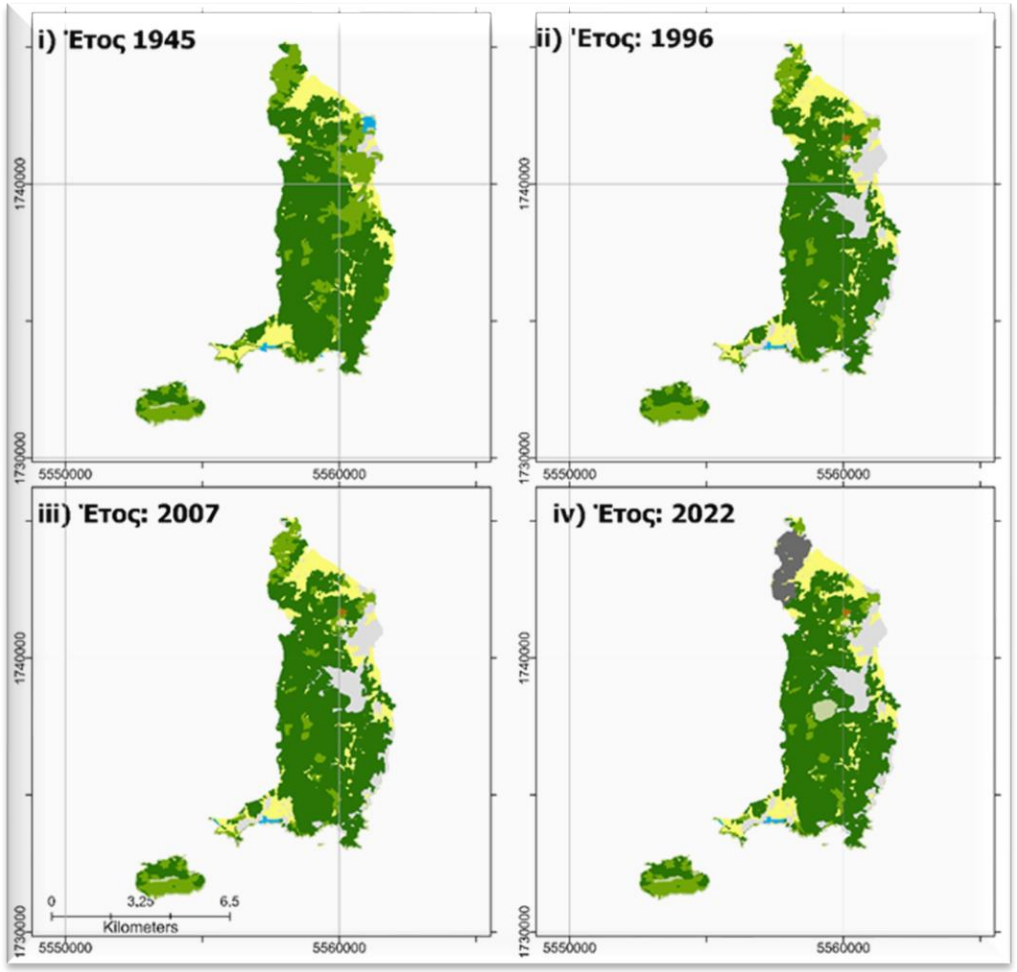


✓ GR 4320002



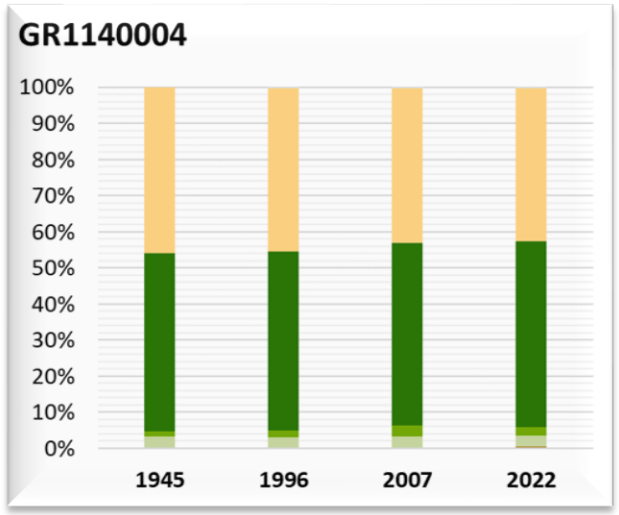
Ecosystem types maps

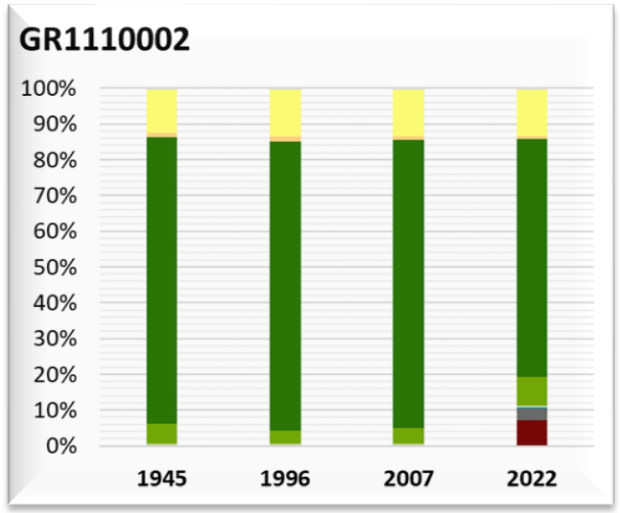
- ✓ GR 3000005

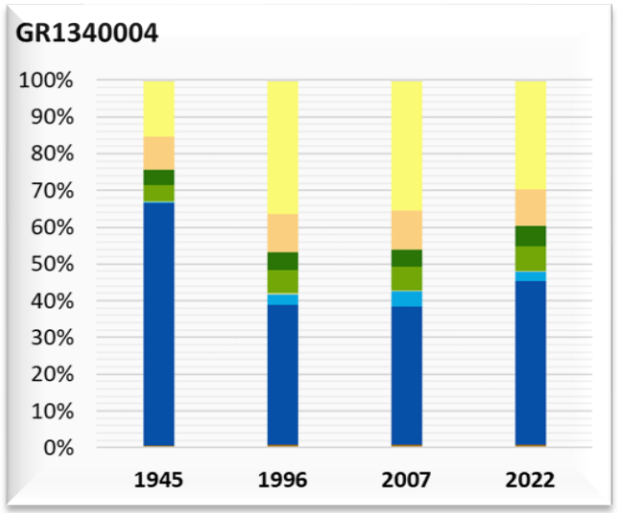


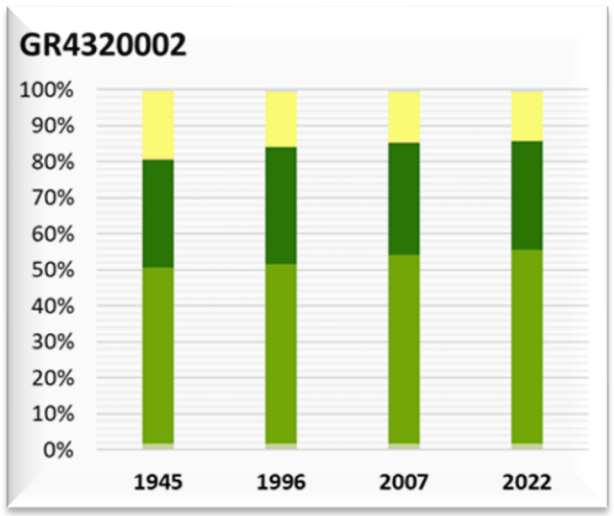
	Urban
	Cropland
	Grassland
	Woodland and Forest
	Heathland and shrub
	Sparsely vegetated land
	Wetlands
	Rivers and lakes
	Mines
	Burned areas
	Burned areas Moderate severity

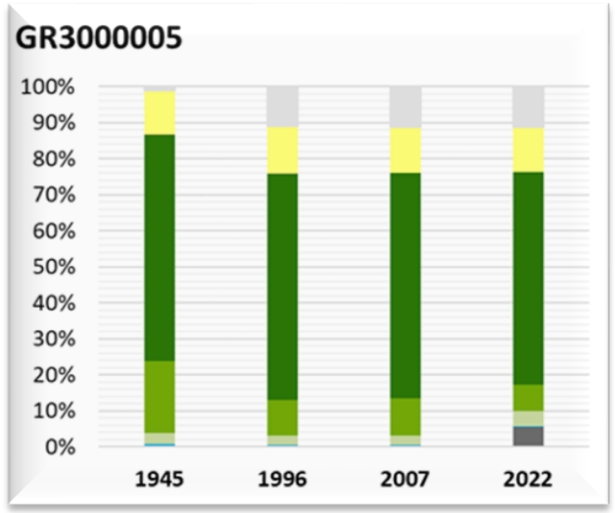
Ecosystem types analysis











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Rivers and lakes
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Burned areas
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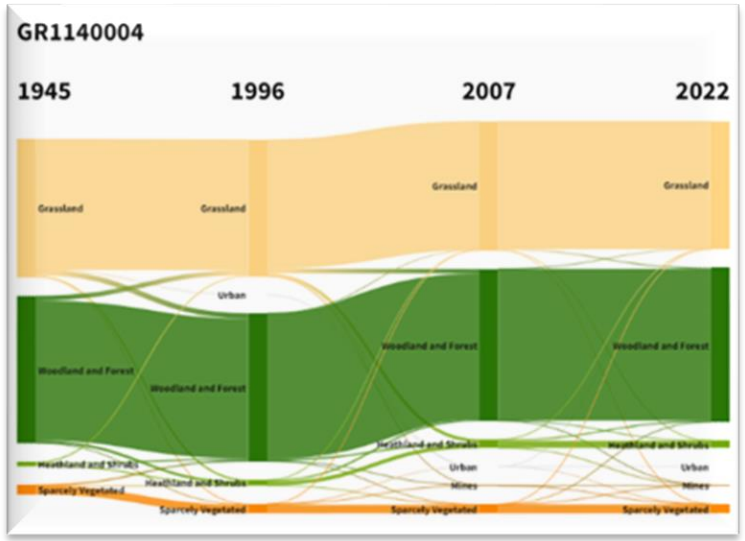
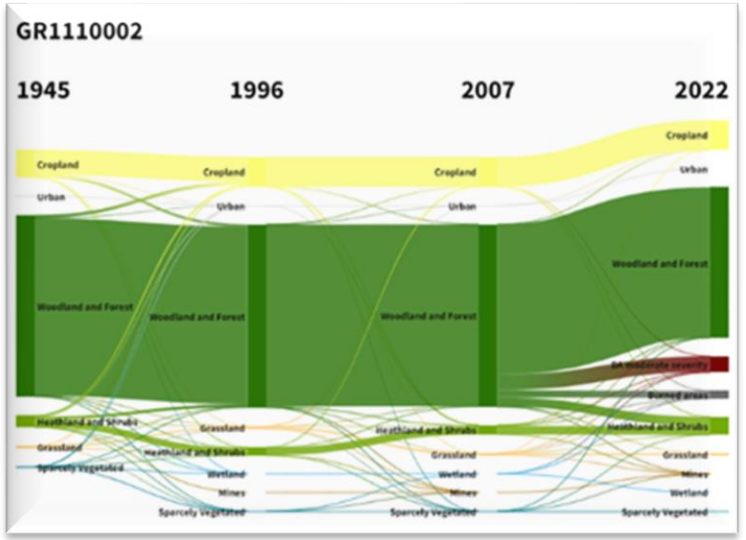
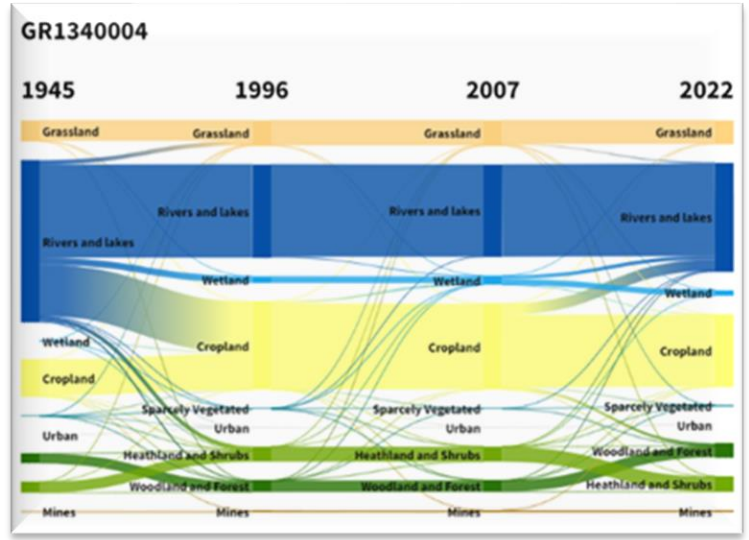
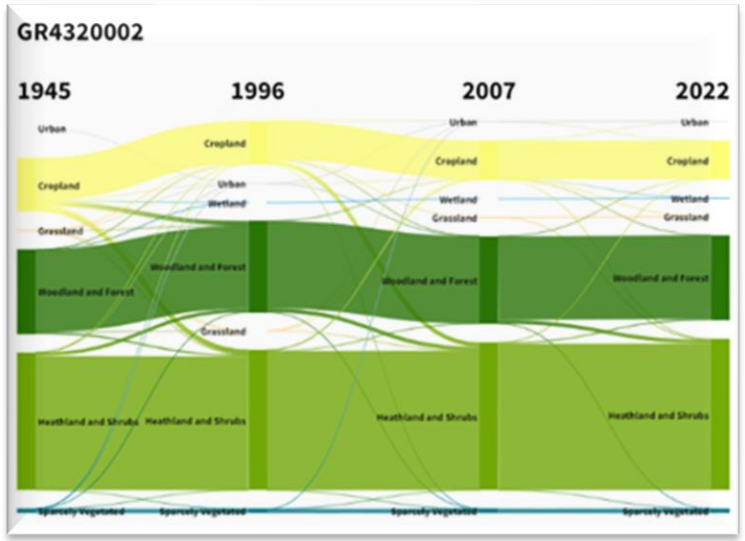
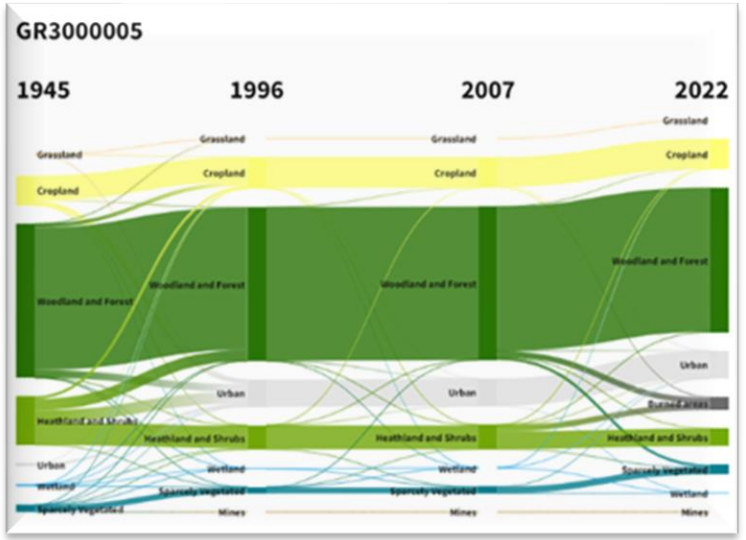
Ecosystem types analysis











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Burned areas
Burned areas Moderate severity

Εδώ ζούμε
Natura 2000

Ecosystem Services maps at local (case study) scale / large scale

Workflow

Data set

Bioclimatic,
Soil data,
EU-DEM ,
River basins,
Ecosystem type maps

Ecosystem Services selection

Carbon Storage

Soil Protection from Erosion

Water Yield

Maximum Potential Water Retention

Nutrient Delivery

InVEST
integrated valuation of ecosystem services and tradeoffs

ppGIS
LIFE-IP 4 NATURA

Ecosystem Services Temporal Maps 1945, 1996, 2007, 2022

Ecosystem Services Changes Maps

Ecosystem Services maps at local scale / large scale

Data sources

Bioclimatic Data

- ✓ CHELSA

Soil Data

- ✓ European Soil Data Centre – ESDAC
- ✓ World Soil Information - ISRIC

Geospatial Data

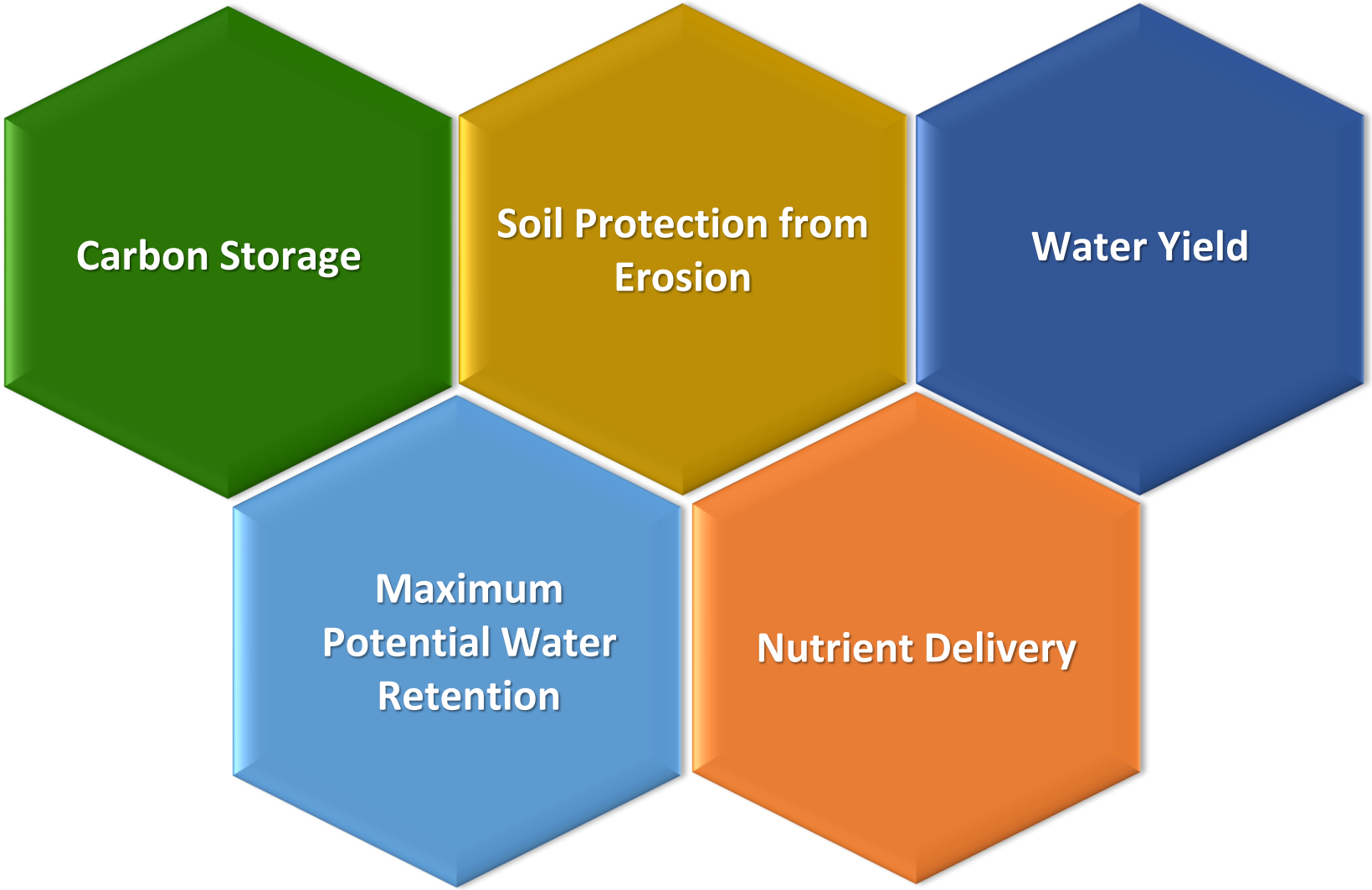
- ✓ European Digital Elevation Model, EU-DEM
- ✓ Joint Research Centre- JRC

LULC

- ✓ Ecosystem type maps (1945-1996-2007-2022)

Ecosystem Services maps at local scale / large scale

Ecosystem Services



InVEST

integrated valuation of ecosystem services and tradeoffs

Ecosystem Services maps at local scale / large scale

Ecosystem Services

Carbon Storage

InVEST
integrated valuation of ecosystem services and tradeoffs

$$C_{total} = \sum_{L=1}^{i} A_i \times (C_{above} + C_{below} + C_{soil} + C_{dead})$$

Input data

- ✓ LULC

- ✓ C_Above
- ✓ C_Below
- ✓ C_Soil
- ✓ C_Dead

Output data

Ecosystem Services maps at local scale / large scale

Ecosystem Services

Soil Protection

InVEST
integrated valuation of ecosystem services and tradeoffs

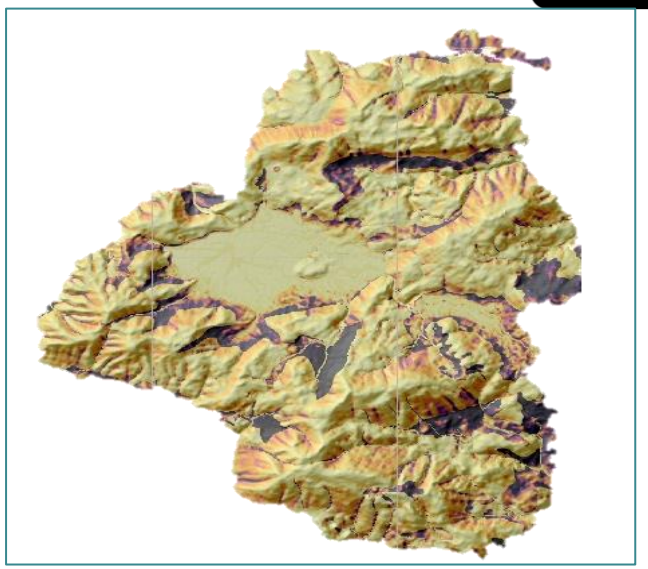
$$AER_i = RLKS_i - USLE_i$$

$$USLE_i = R_i \cdot K_i \cdot LS_i \cdot C_i \cdot P_i$$

Input data

- ✓ DEM
- ✓ Soil Erodibility
- ✓ LULC
- ✓ Biophysical Table
- ✓ Erosivity
- ✓ Watersheds
- ✓ Threshold Flow Accumulation
- ✓ Borselli K Parameter
- ✓ Maximum L Value

Output data



Ecosystem Services maps at local scale / large scale

Ecosystem Services

Water Yield

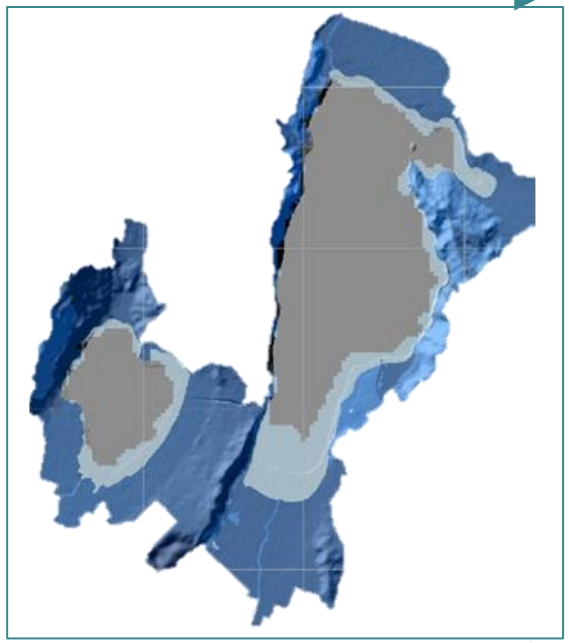
InVEST
integrated valuation of ecosystem services and tradeoffs

$$Y(x) = \left(1 - \frac{AET_{(x)}}{P(x)}\right) \times P(x)$$

Input data

- ✓ Precipitation
- ✓ LULC
- ✓ Evapotranspiration
- ✓ Root Restricting Layer Depth
- ✓ Plant Available Water Content
- ✓ Z Parameter
- ✓ Watersheds
- ✓ Biophysical parameters

Output data



Ecosystem Services

Water Retention

GIS

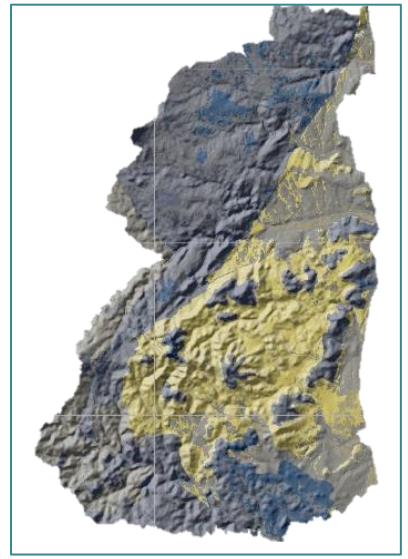
$$YS = \frac{25400}{CN} - 254$$

CNII = 6 × iVEG + 9 × iPERM +3 × iSLOPE + 10

Input data

- ✓ LULC
- ✓ Permeability
- ✓ Drainage Capacity

Output data



Ecosystem Services maps at local scale / large scale

Ecosystem Services

Nutrient Delivery

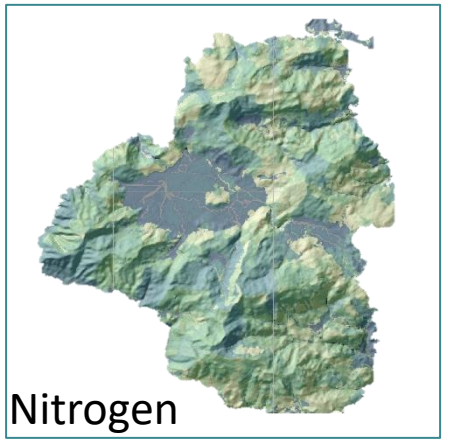
InVEST
integrated valuation of ecosystem services and tradeoffs

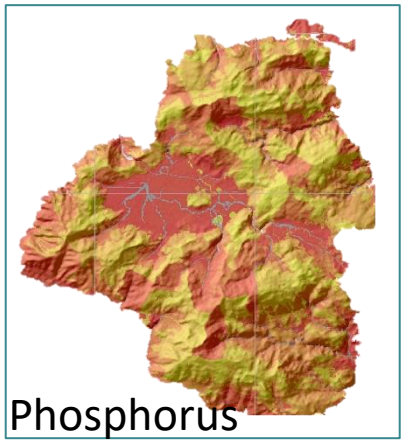
$$X_{exp} = load_{surf,I} \times NBR_{surfi} + load_{sub,I} \times NBR_{subi}$$

Input data

Output data

- ✓ DEM
- ✓ LULC
- ✓ Nutrient Runoff Proxy
- ✓ Watersheds
- ✓ Biophysical parameters
- ✓ Threshold Flow Accumulation
- ✓ Borselli K Parameter

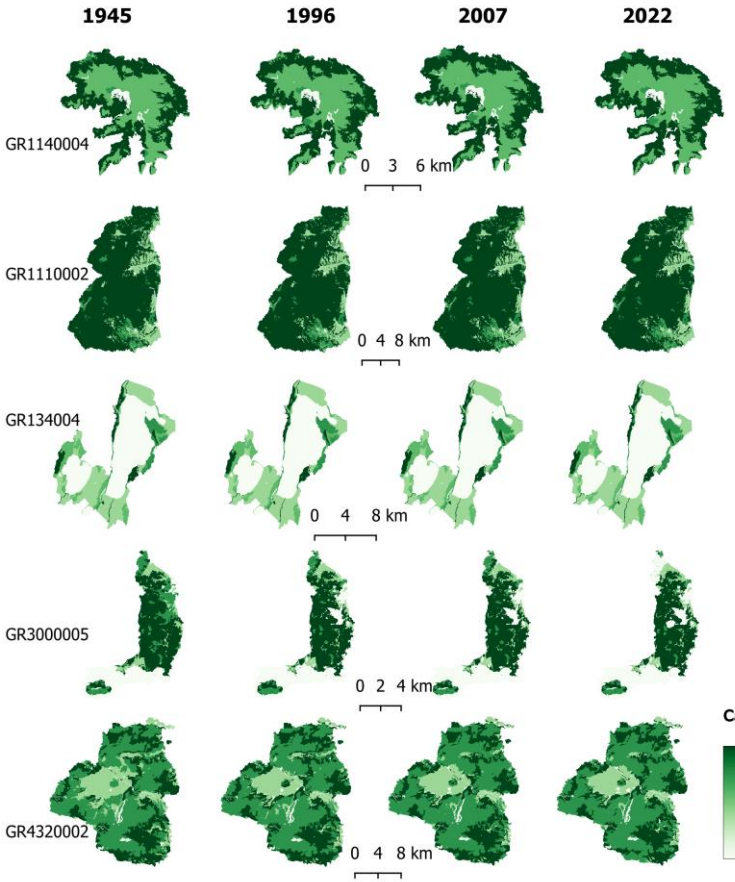

Nitrogen


Phosphorus

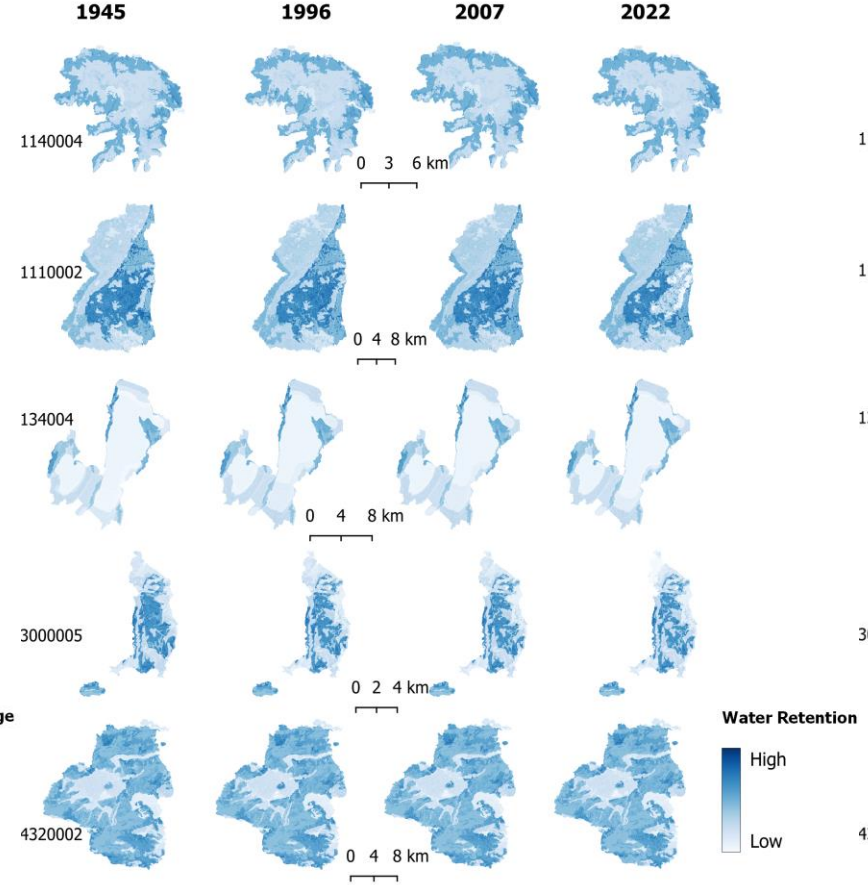
Ecosystem Services maps at local scale / large scale

Ecosystem Services maps

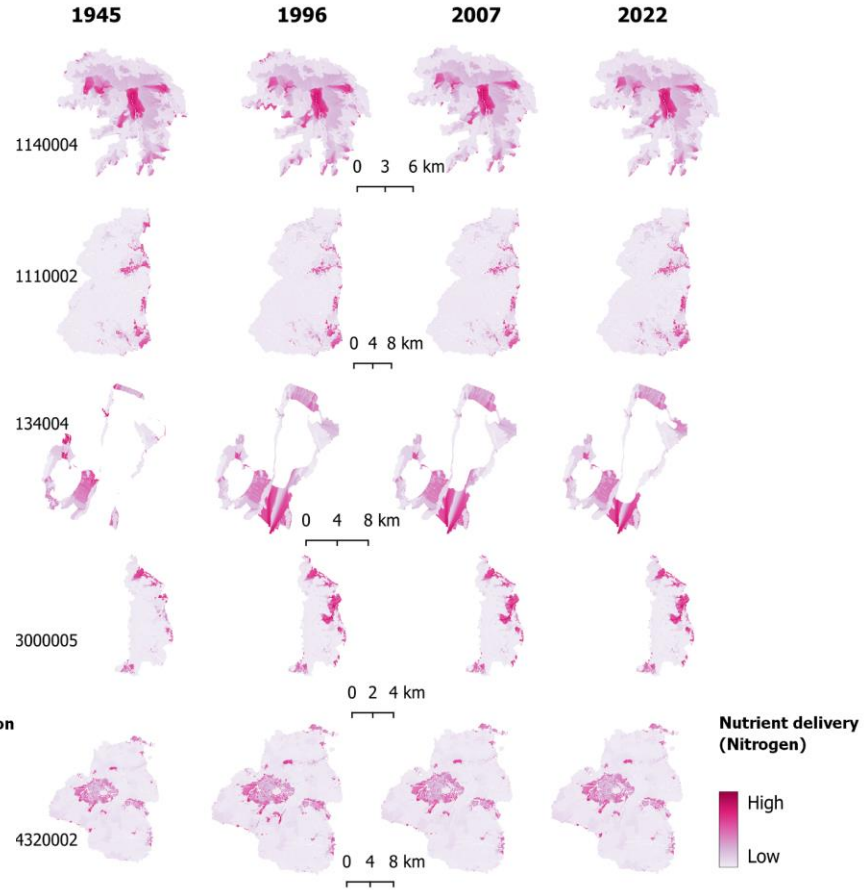
✓ Carbon storage



✓ Water Retention



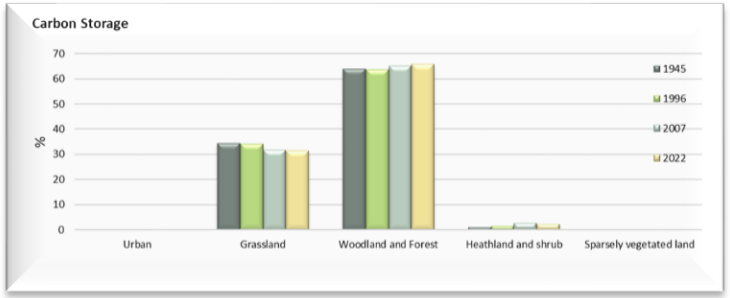
✓ Nutrient delivery

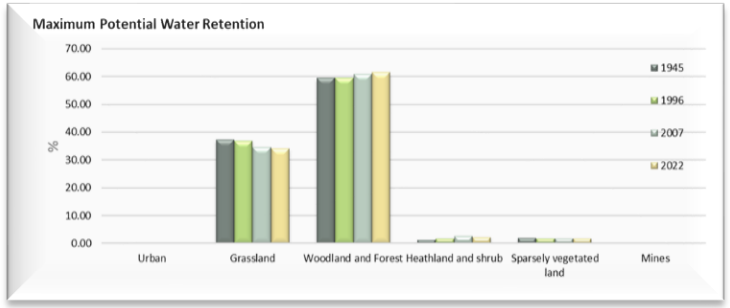


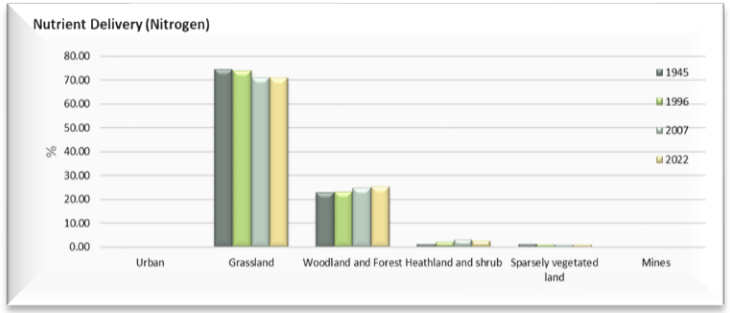
Ecosystem Services maps at local scale / large scale

Ecosystem Services analysis

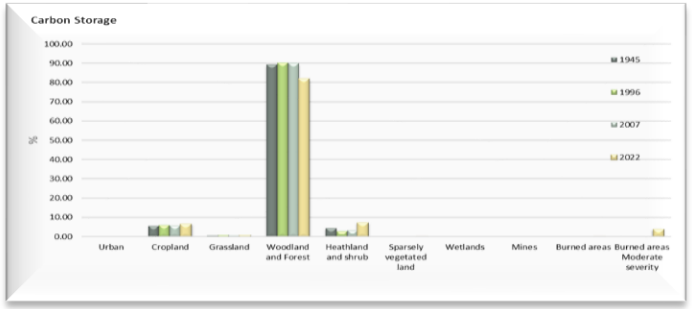
✓ GR1140004

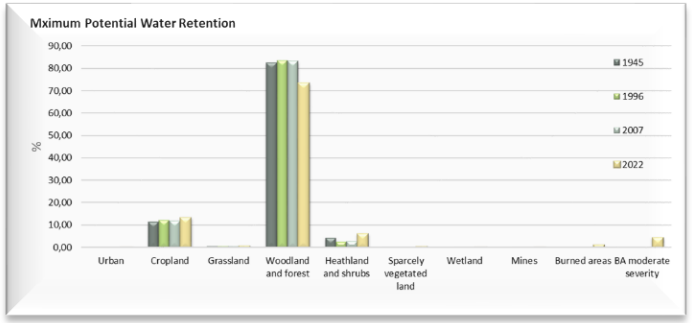


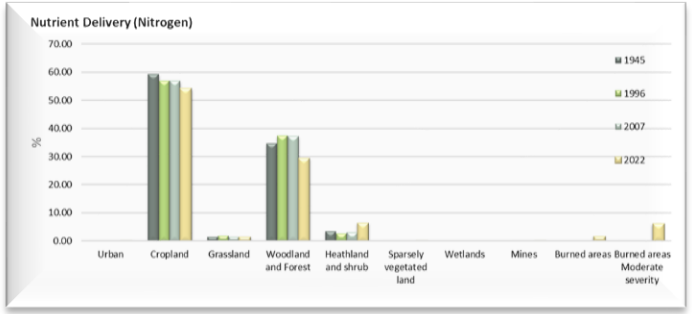




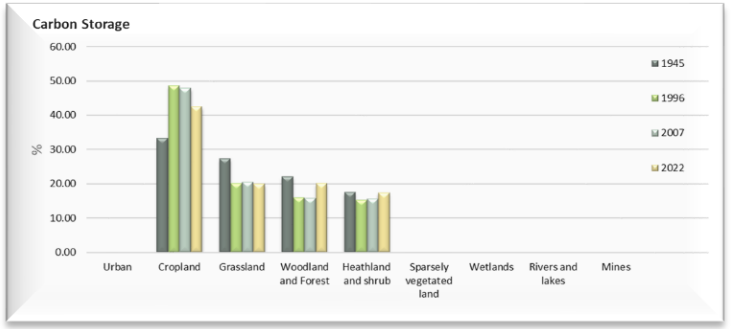
✓ GR1110002

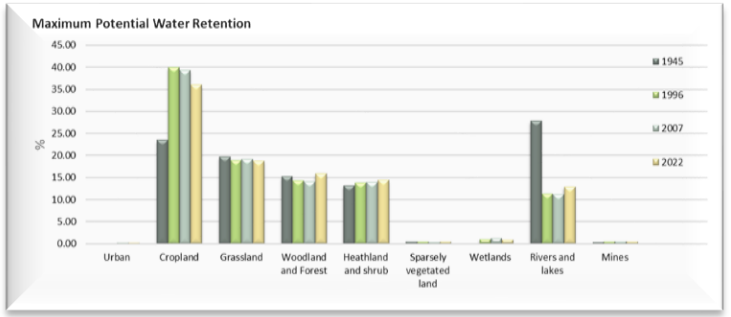


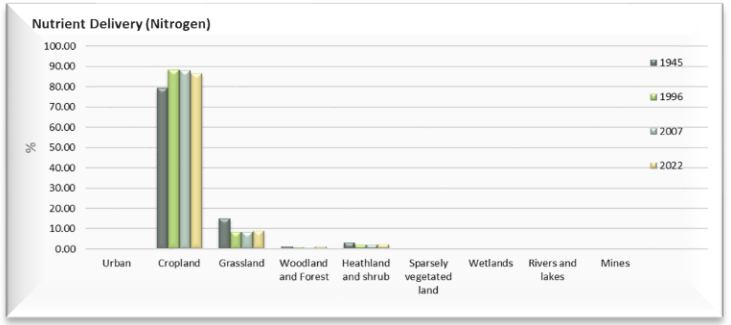




✓ GR1340004



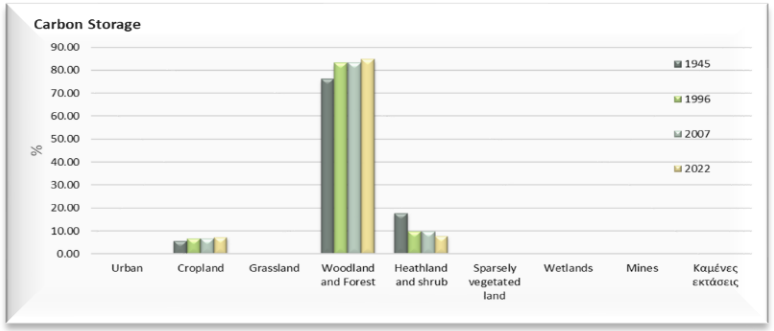


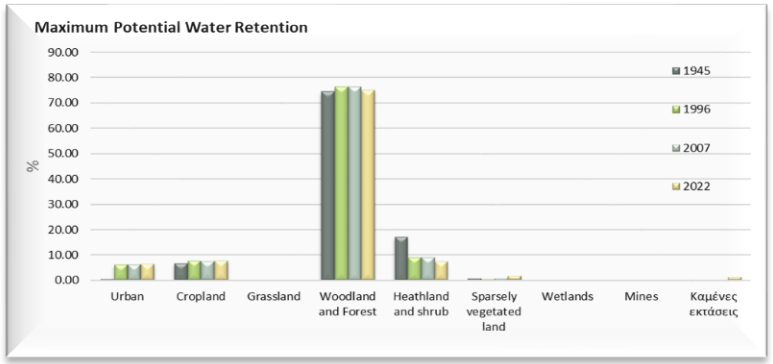


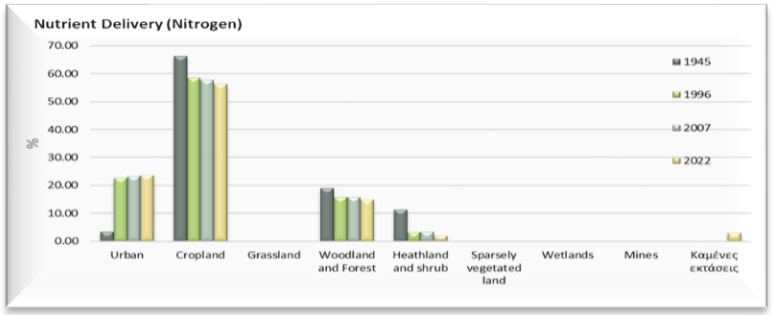
Ecosystem Services maps at local scale / large scale

Ecosystem Services analysis

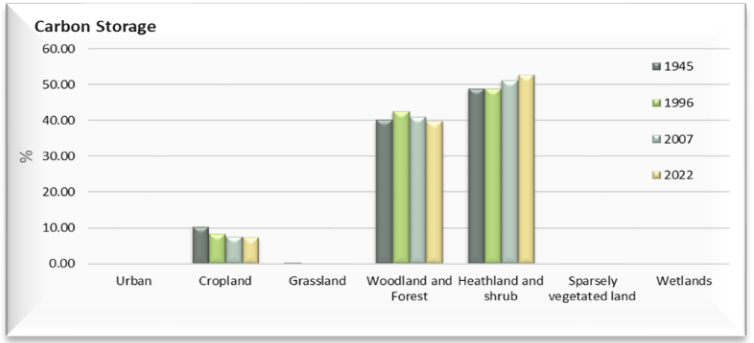
✓ GR 3000005

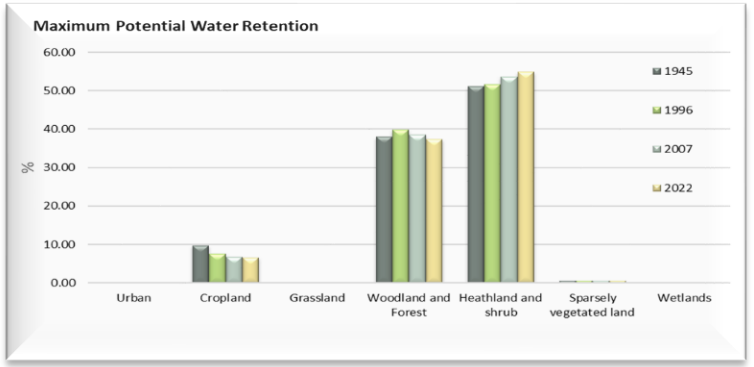


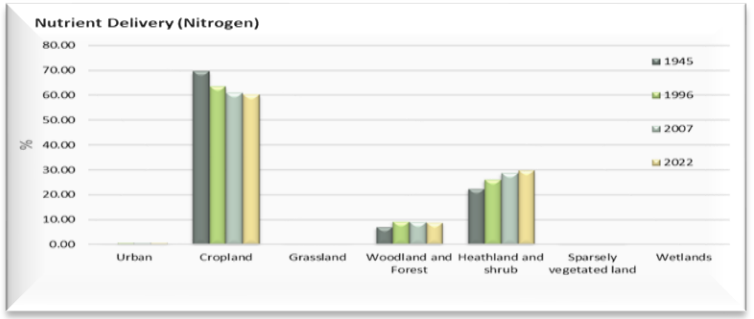




✓ GR 4320002



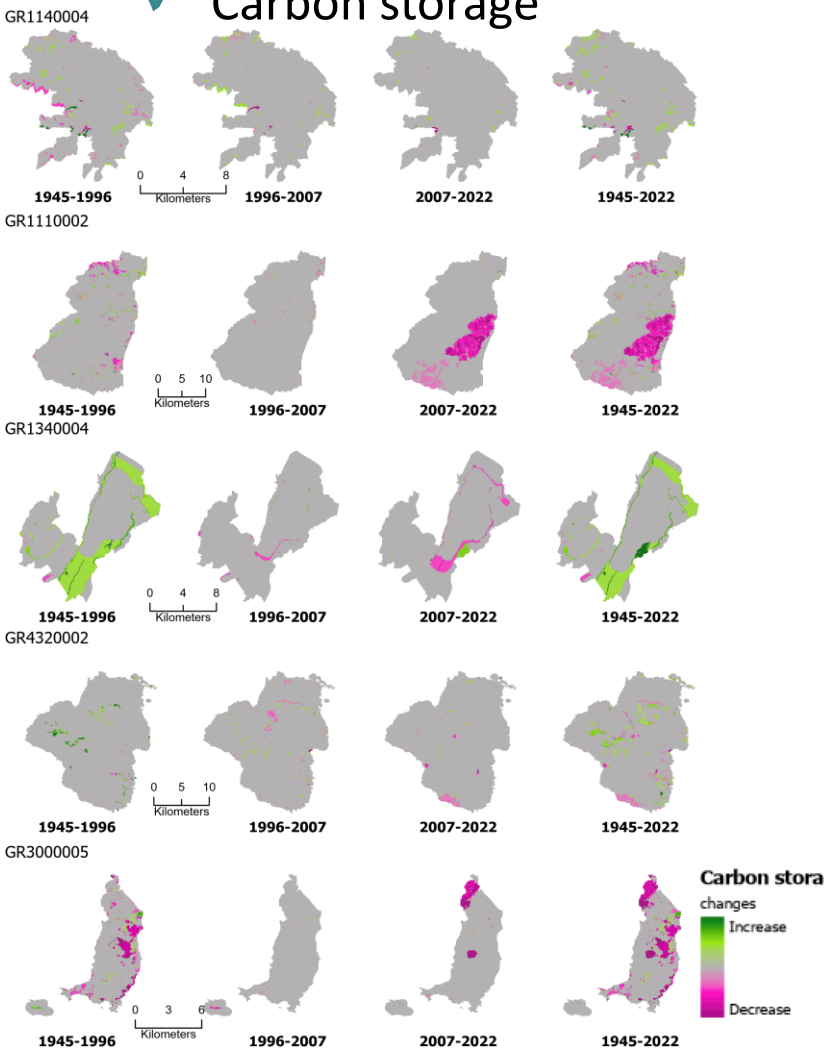




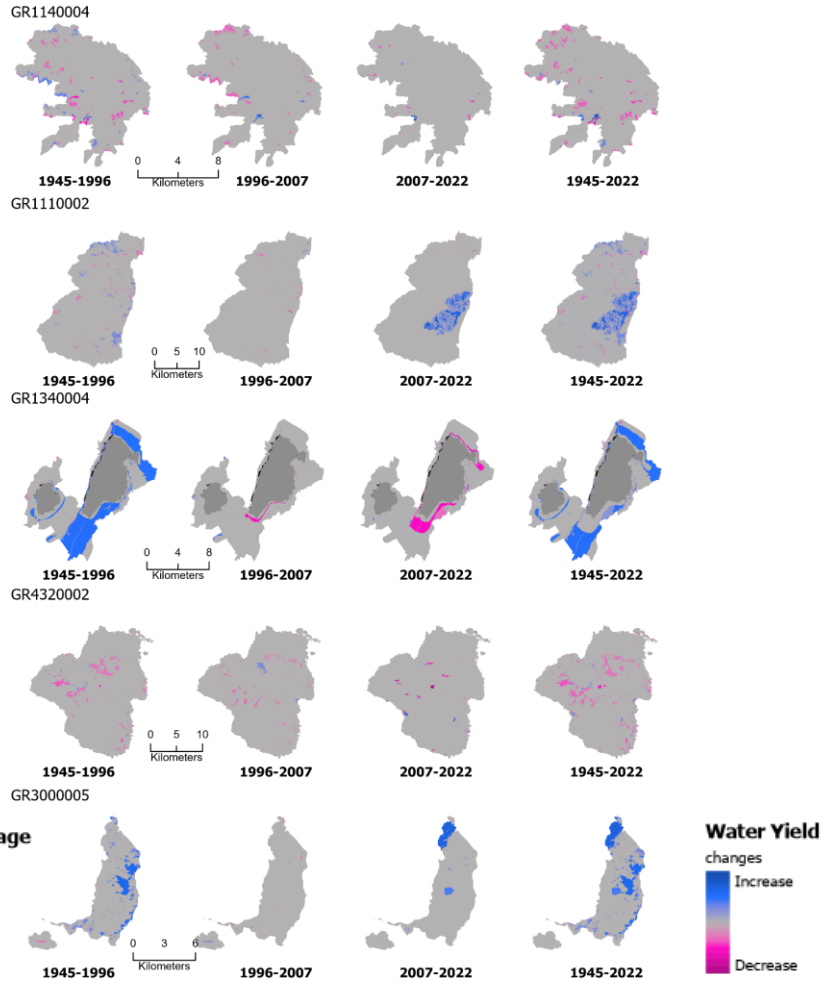
Ecosystem Services maps at local scale / large scale

Ecosystem Services changes

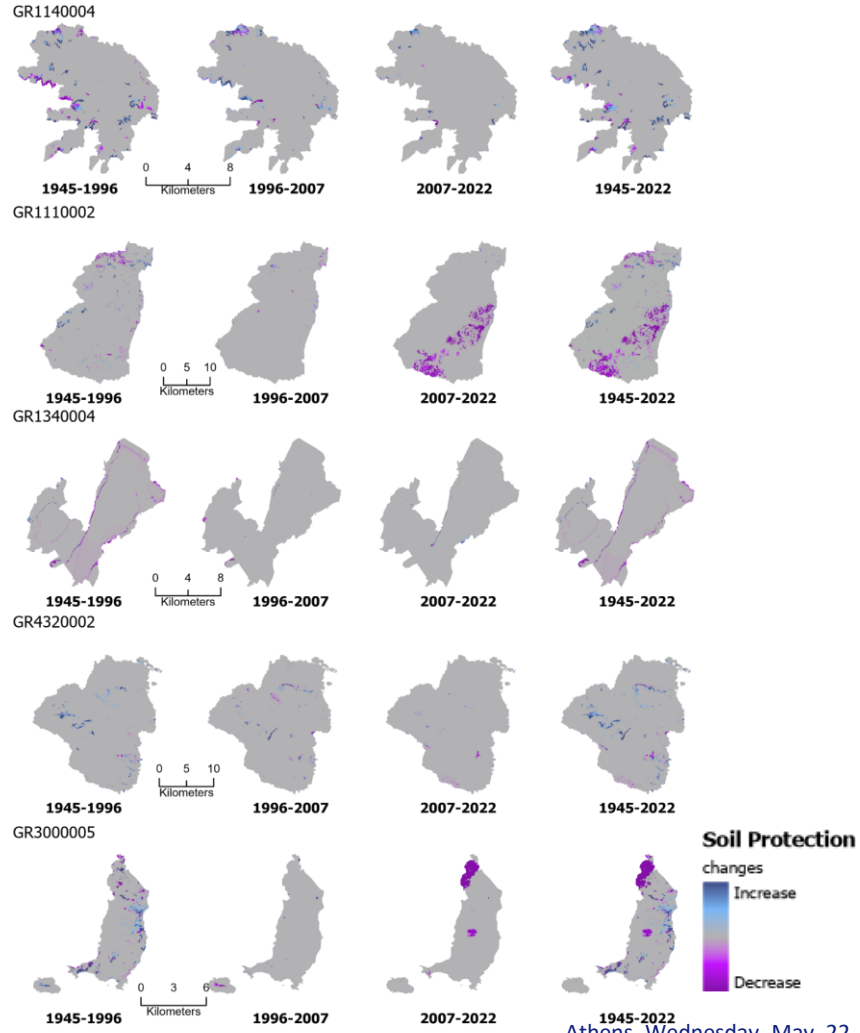
✓ Carbon storage



✓ Water Yield



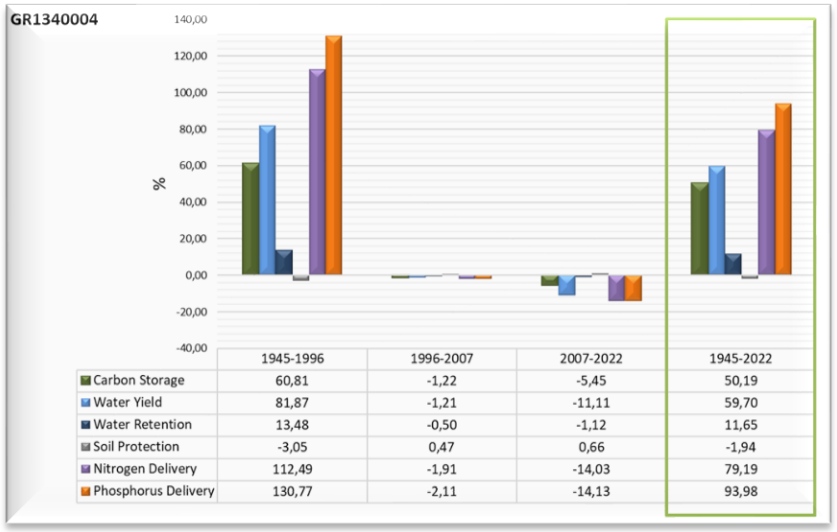
✓ Soil protection



Ecosystem Services maps at local scale / large scale

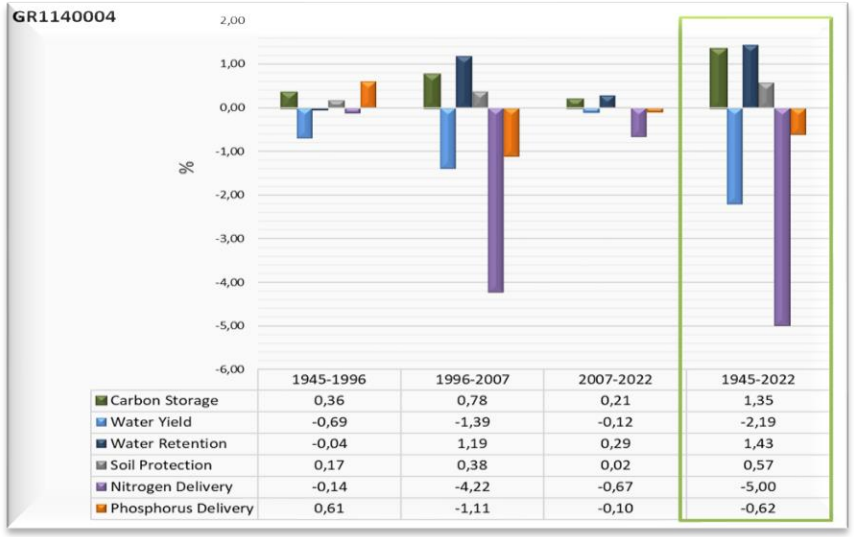
Ecosystem Services changes analysis

GR1340004



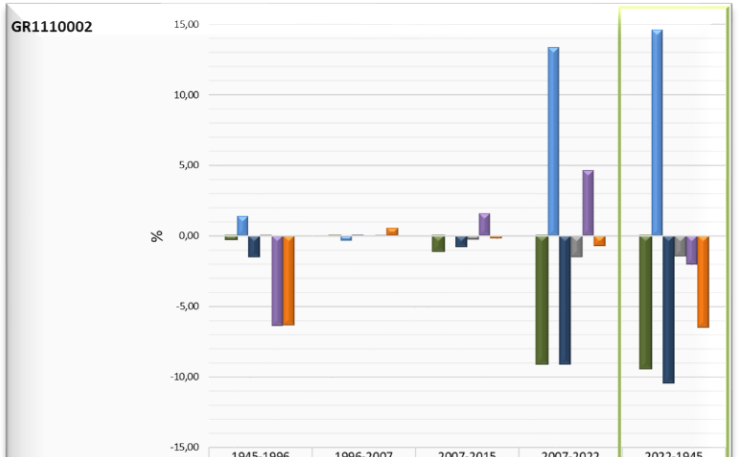
	1945-1996	1996-2007	2007-2022	1945-2022
Carbon Storage	60,81	-1,22	-5,45	50,19
Water Yield	81,87	-1,21	-11,11	59,70
Water Retention	13,48	-0,50	-1,12	11,65
Soil Protection	-3,05	0,47	0,66	-1,94
Nitrogen Delivery	112,49	-1,91	-14,03	79,19
Phosphorus Delivery	130,77	-2,11	-14,13	93,98

GR1140004



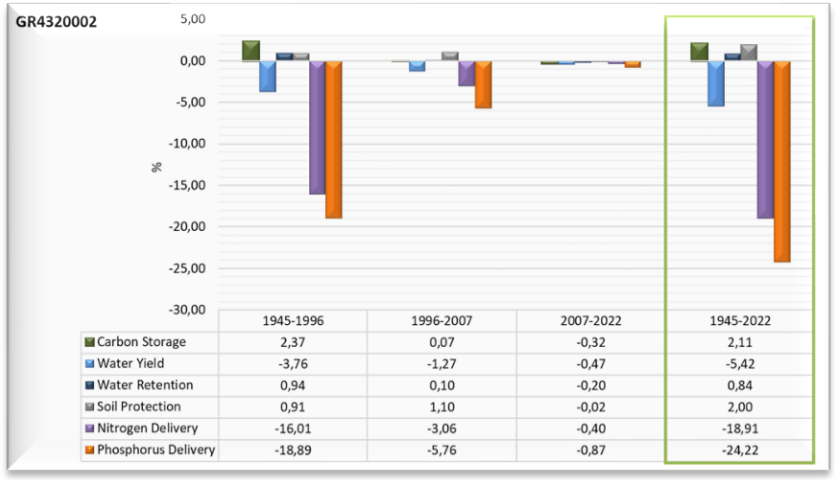
	1945-1996	1996-2007	2007-2022	1945-2022
Carbon Storage	0,36	0,78	0,21	1,35
Water Yield	-0,69	-1,39	-0,12	-2,19
Water Retention	-0,04	1,19	0,29	1,43
Soil Protection	0,17	0,38	0,02	0,57
Nitrogen Delivery	-0,14	-4,22	-0,67	-5,00
Phosphorus Delivery	0,61	-1,11	-0,10	-0,62

GR1110002



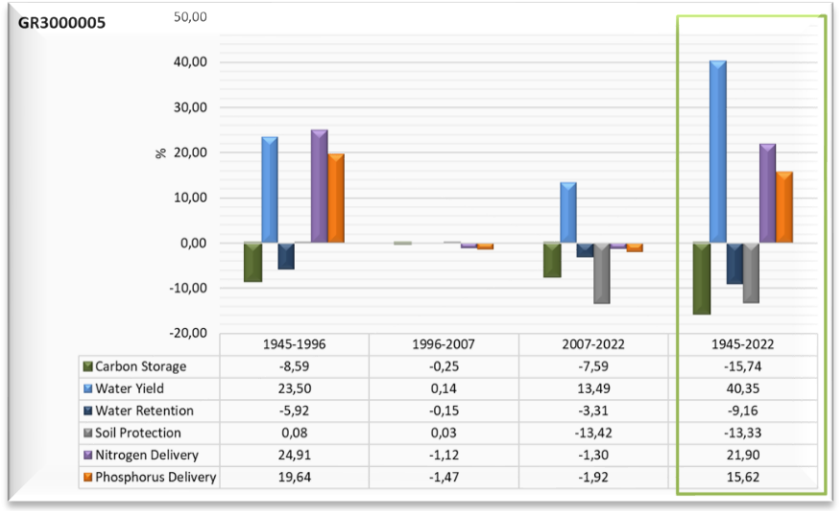
	1945-1996	1996-2007	2007-2015	2007-2022	2022-1945
Carbon Storage	-0,31	-0,06	-1,14	-9,09	-9,43
Water Yield	1,41	-0,33	-0,02	13,39	14,61
Water Retention	-1,53	0,05	-0,86	-9,12	-10,47
Soil Protection	0,05	0,00	-0,28	-1,52	-1,47
Nitrogen Delivery	-6,40	0,04	1,58	4,62	-2,04
Phosphorus Delivery	-6,33	0,55	-0,20	-0,75	-6,52

GR4320002



	1945-1996	1996-2007	2007-2022	1945-2022
Carbon Storage	2,37	0,07	-0,32	2,11
Water Yield	-3,76	-1,27	-0,47	-5,42
Water Retention	0,94	0,10	-0,20	0,84
Soil Protection	0,91	1,10	-0,02	2,00
Nitrogen Delivery	-16,01	-3,06	-0,40	-18,91
Phosphorus Delivery	-18,89	-5,76	-0,87	-24,22

GR3000005



	1945-1996	1996-2007	2007-2022	1945-2022
Carbon Storage	-8,59	-0,25	-7,59	-15,74
Water Yield	23,50	0,14	13,49	40,35
Water Retention	-5,92	-0,15	-3,31	-9,16
Soil Protection	0,08	0,03	-13,42	-13,33
Nitrogen Delivery	24,91	-1,12	-1,30	21,90
Phosphorus Delivery	19,64	-1,47	-1,92	15,62

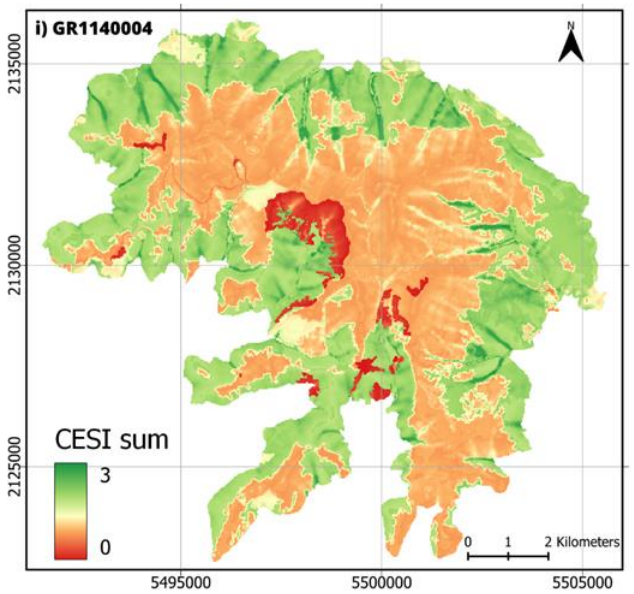
Ecosystem Services changes 1945- 2022

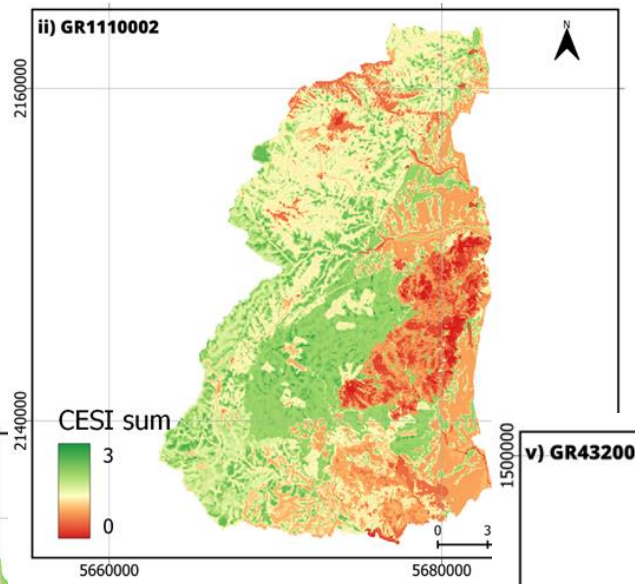
	GR1140004	GR1110002	GR1340004	GR3000005	GR4320002
Carbon Storage	↑	↓	↑	↓	↑
Water Yield	↓	↑	↑	↑	↓
Maximum Potential Water Retention	↑	↓	↑	↓	↑
Soil Protection from Erosion	↑	↓	↓	↓	↑
Nutrient Delivery (Nitrogen)	↓	↓	↑	↑	↓
Nutrient Delivery (Phosphorus)	↓	↓	↑	↑	↓

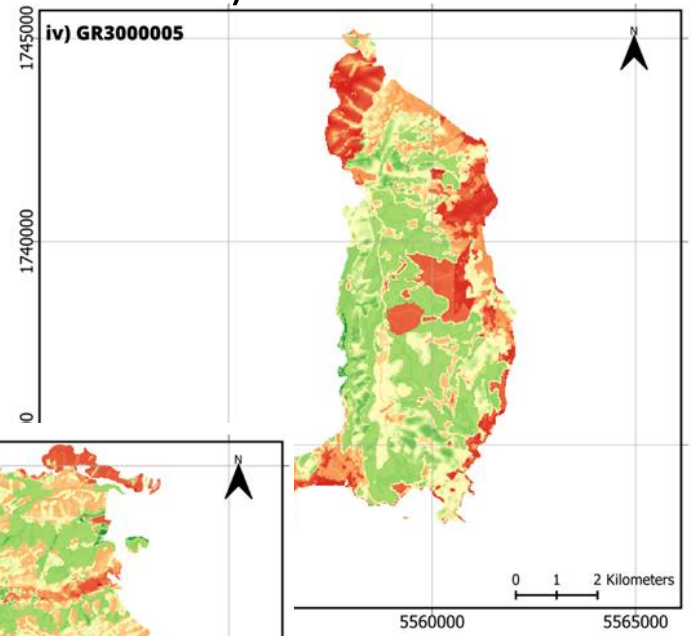
Ecosystem Services maps at local scale / large scale

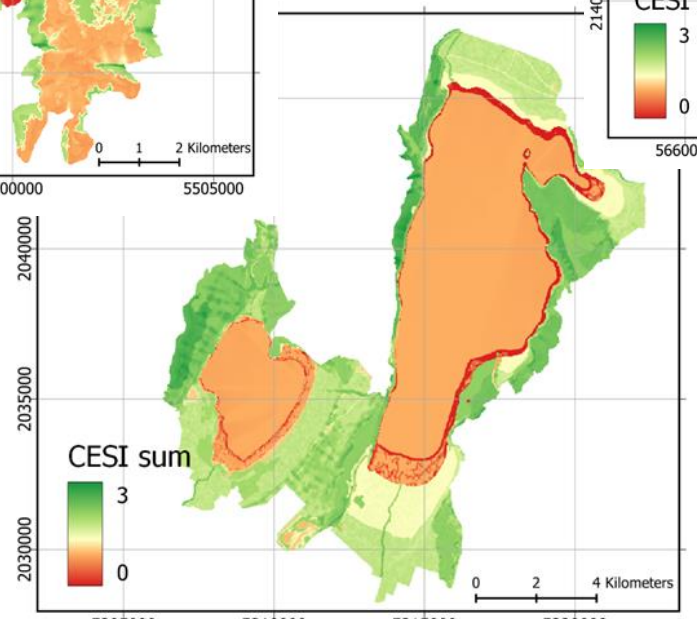
Ecosystem Services status 2022

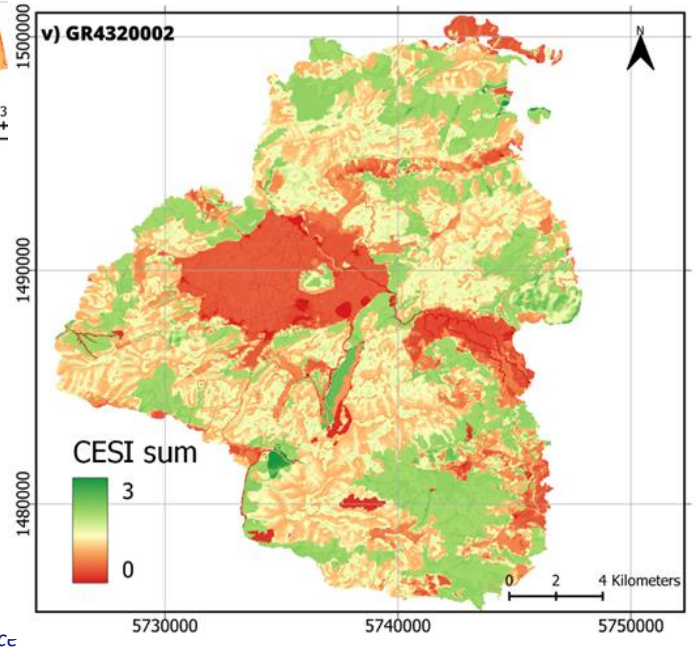
✓ Comprehensive ecosystem services index (Carbon storage + Soil protection +Water Retention)







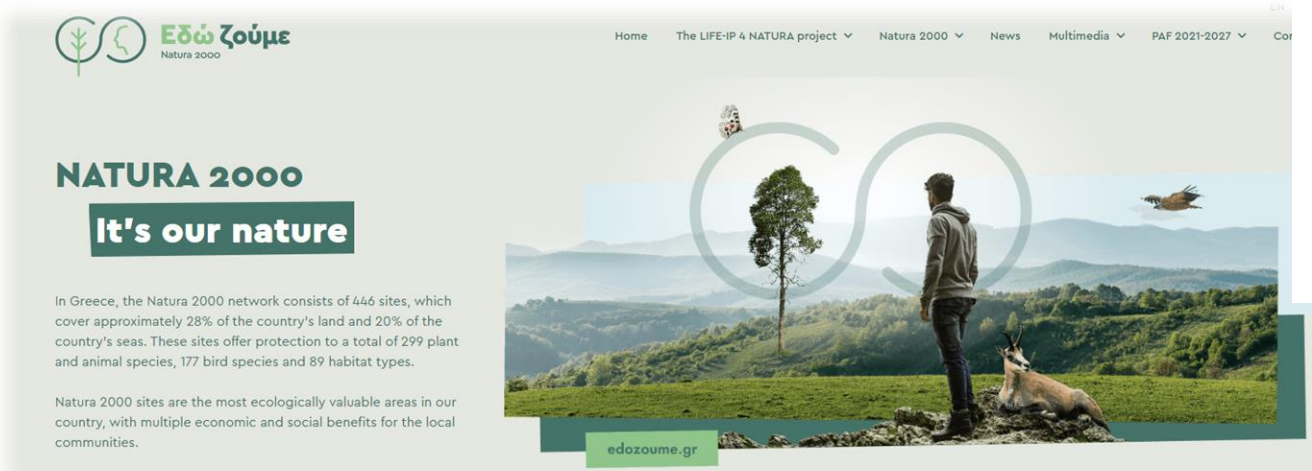




Εδώ ζούμε
Natura 2000

ppGIS/webGIS LIFE-IP 4 NATURA

The site



https://edozoume.gr/

Public Participation GIS

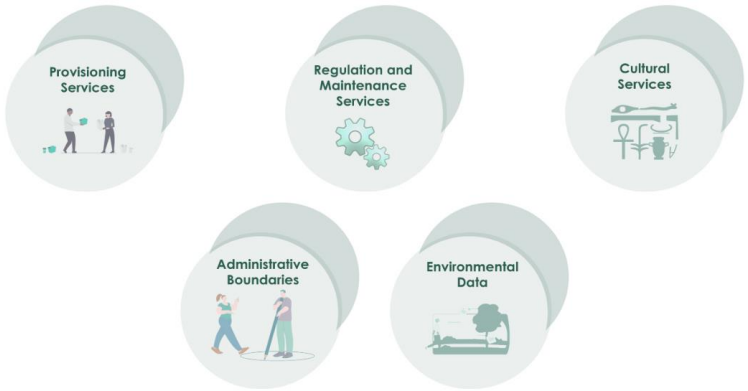
ppGIS/WebGIS' Practical Guide | ppGIS/WebGIS' Technical Report | EN | GR

The web-based Public Participation Geographic Information System of the LIFE-IP 4 Natura project (ppGIS/webGIS LIFE-IP 4 NATURA), presents at a national scale the ecosystem services (such as timber production, climate regulation, erosion regulation, recreation provision, etc.) that Greek ecosystems offer to the public. The ppGIS/webGIS LIFE-IP 4 NATURA was designed and developed within the framework of the LIFE-IP 4 Natura project by the Aristotle University of Thessaloniki - School of Rural and Surveying Engineering, in collaboration with the University of Patras - Department of Biology, the Natural Environment and Climate Change Agency (NECCA), the Greek Ministry of Environment and Energy and WWF Greece.

✓ Public Participation - Web Applications

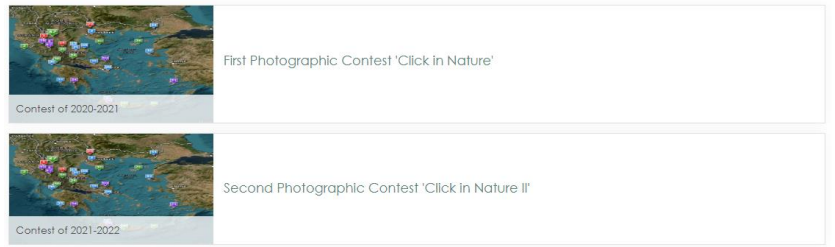
✓ Story maps

✓ Explore the Dara

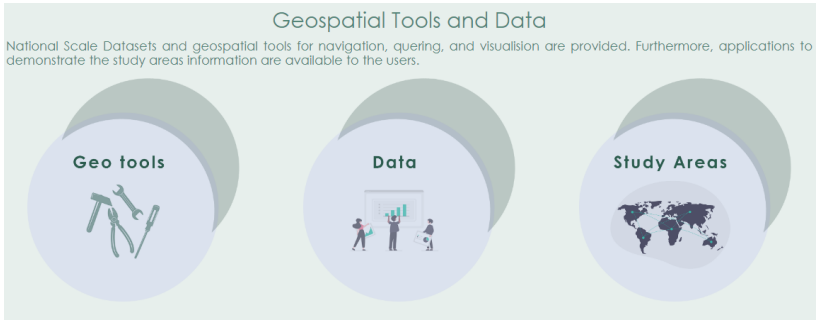


✓ Public Participation Mobile App

✓ Photographic Contests



✓ Geospatial tools and data



✓ ES-pedia

https://gis-natura.gr/

Geotools

Story Map with data organized per category

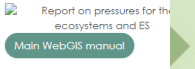
The following application provides user friendly access to the main WebGIS Data. The data is organized per thematic category and additional tool for querying and downloading are provided.

Web GIS Story Map

Main WebGIS

The following application provides user friendly access to the main WebGIS Data. The data are categorized and easy to use tools for search and data download are provided. You can navigate in the webGIS features through the manual "Story Map"

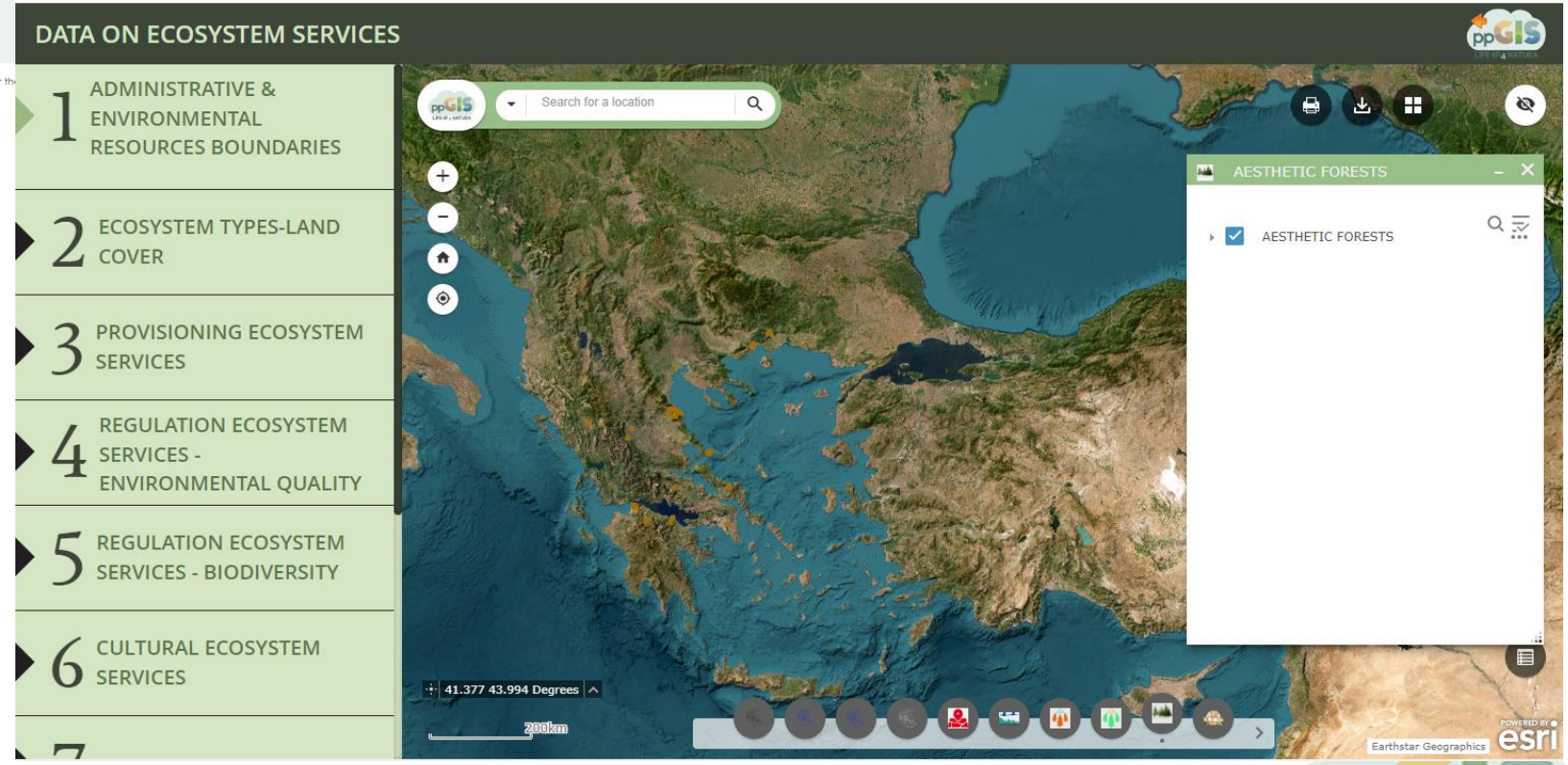
Access the main webGIS



Report on pressures for th… ecosystems and ES

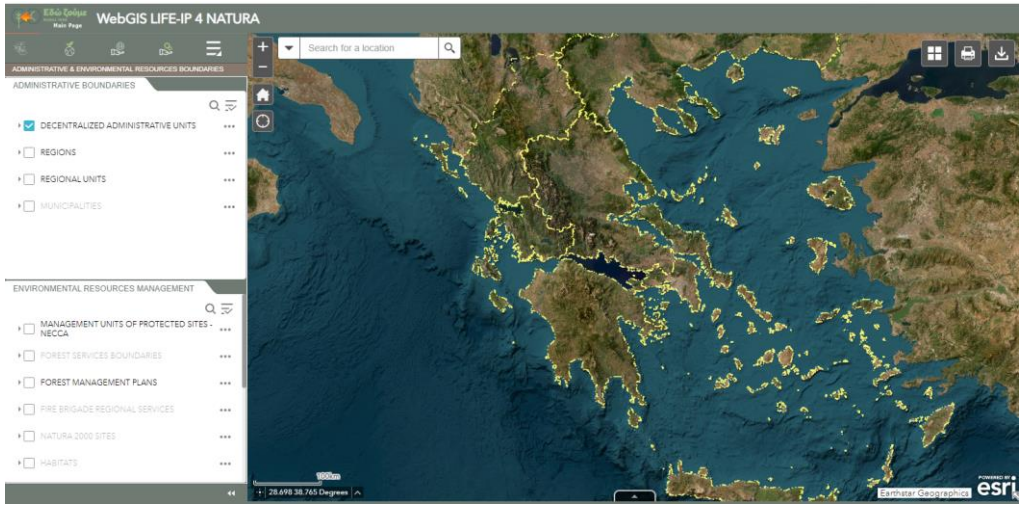
Main WebGIS manual

- ✓ Story map data organized per category

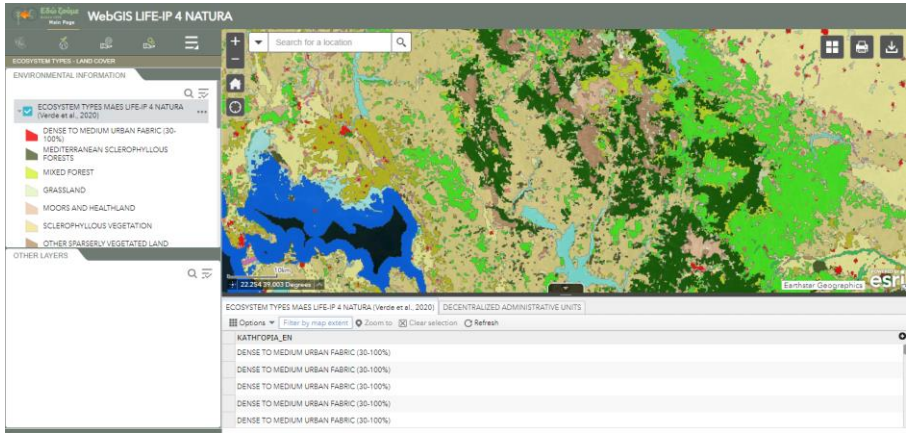


Geotools – WebGIS

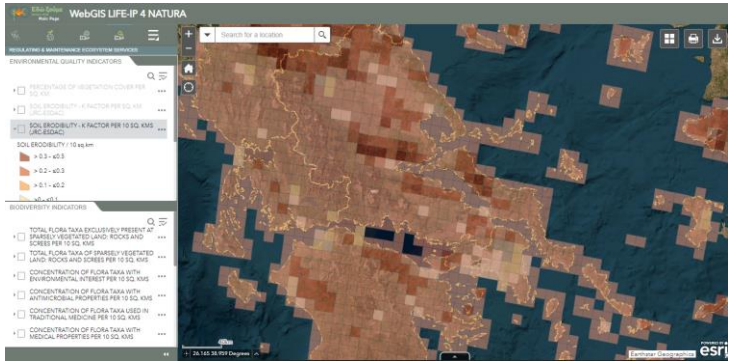
✓ Administrative & Environmental resources boundaries



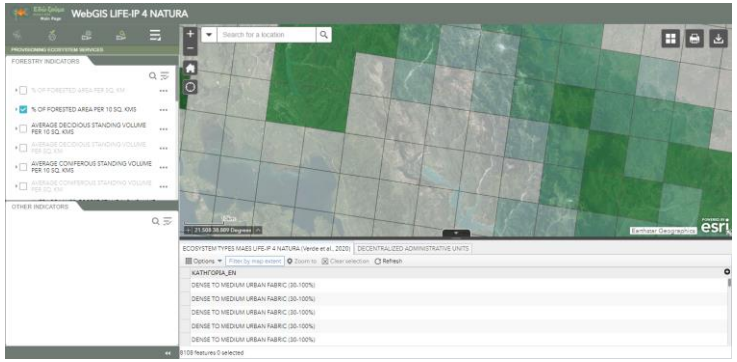
✓ Ecosystem types – land cover



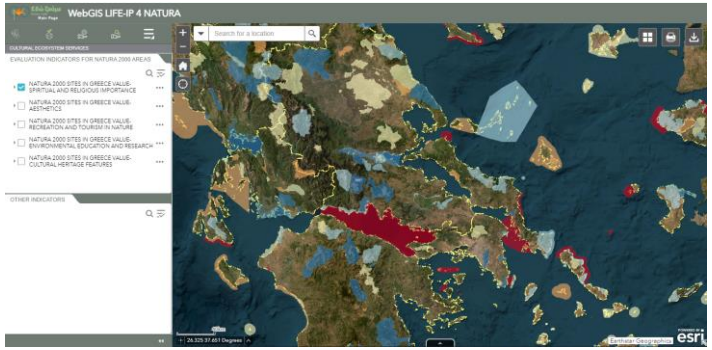
✓ Regulating & maintenance Ecosystem services



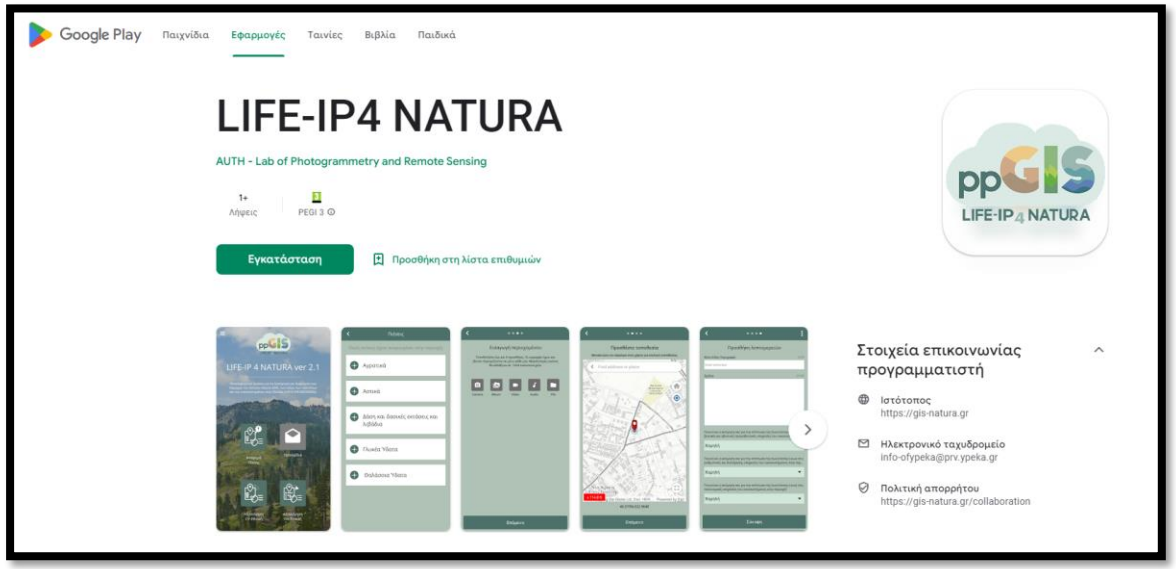
✓ Provisioning Ecosystem services



✓ Cultural Ecosystem services



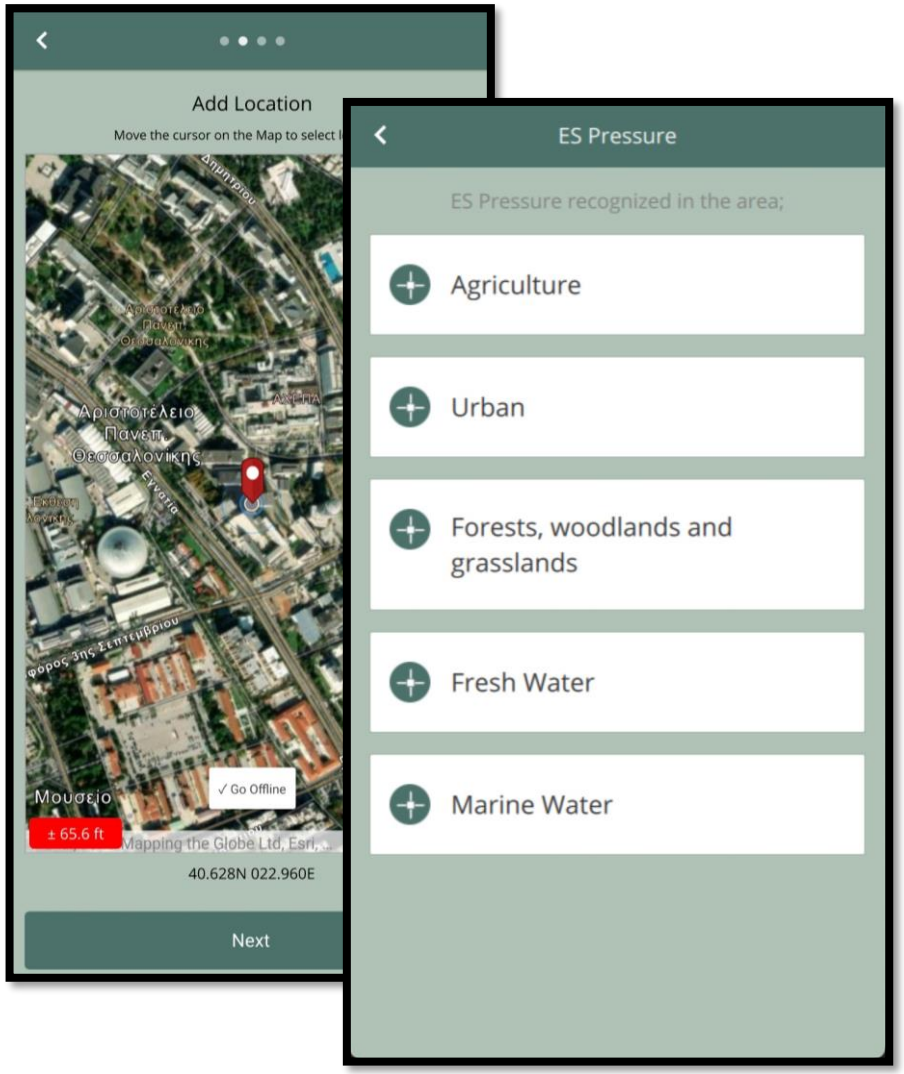
The app

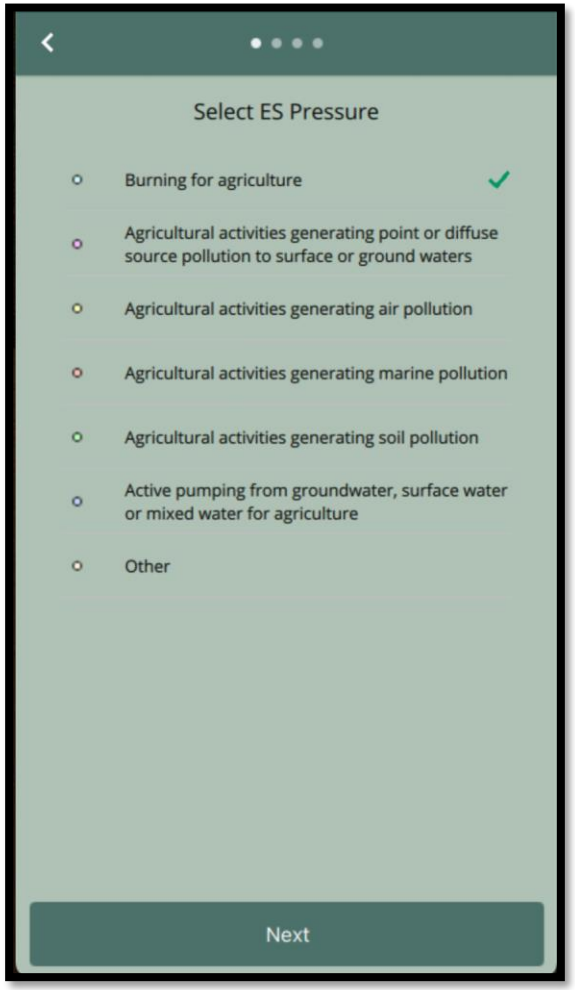


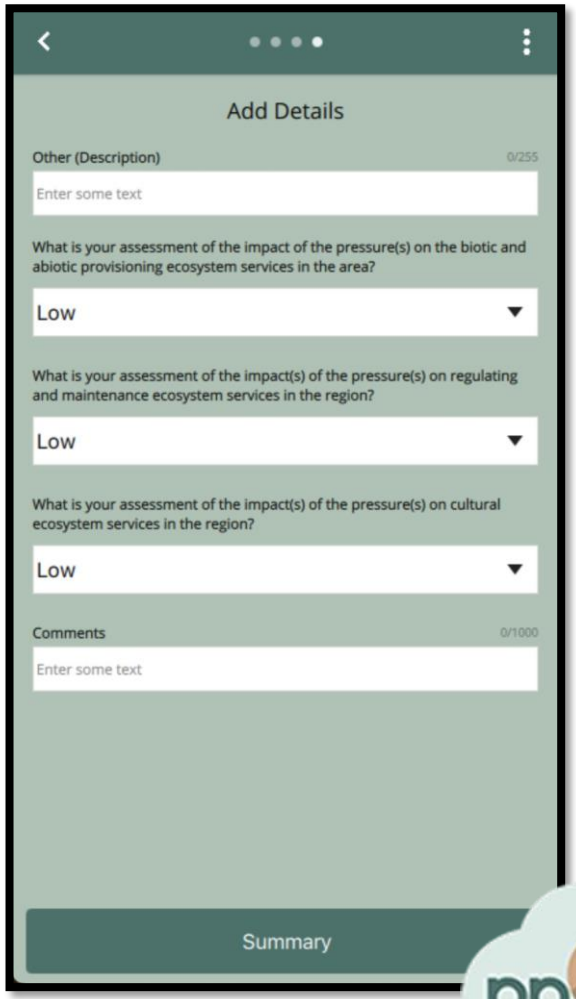
SCAN ME

ppGIS LIFE-IP 4 NATURA

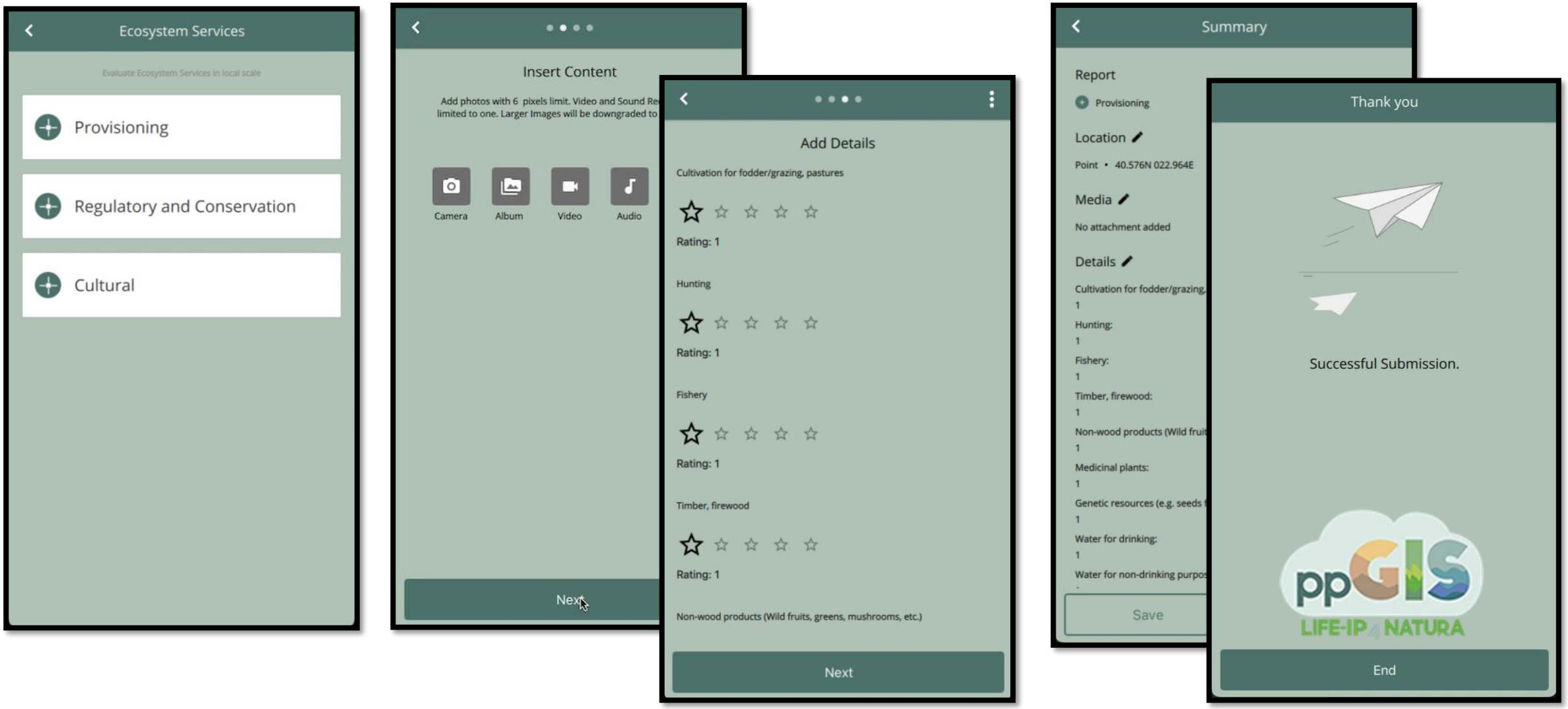
The app


Add Location
Move the cursor on the Map to select
Αριστοτέλειο Πανεπιστήμιο Θεσσαλονίκης
Μουσείο
✓ Go Offline
± 65.6 ft
Mapping the Globe Ltd, Esri,
40.628N 022.960E
Next
ES Pressure
ES Pressure recognized in the area;
Agriculture
Urban
Forests, woodlands and grasslands
Fresh Water
Marine Water


Select ES Pressure
Burning for agriculture
Agricultural activities generating point or diffuse source pollution to surface or ground waters
Agricultural activities generating air pollution
Agricultural activities generating marine pollution
Agricultural activities generating soil pollution
Active pumping from groundwater, surface water or mixed water for agriculture
Other
Next


Add Details
Other (Description)
0/255
Enter some text
What is your assessment of the impact of the pressure(s) on the biotic and abiotic provisioning ecosystem services in the area?
Low
What is your assessment of the impact(s) of the pressure(s) on regulating and maintenance ecosystem services in the region?
Low
What is your assessment of the impact(s) of the pressure(s) on cultural ecosystem services in the region?
Low
Comments
0/1000
Enter some text
Summary

The app


Ecosystem Services
Evaluate Ecosystem Services in local scale
Provisioning
Regulatory and Conservation
Cultural
Insert Content
Add photos with 6 pixels limit. Video and Sound Re
limited to one. Larger Images will be downgraded to
Camera
Album
Video
Audio
Next
Add Details
Cultivation for fodder/grazing, pastures
Rating: 1
Hunting
Rating: 1
Fishery
Rating: 1
Timber, firewood
Rating: 1
Non-wood products (Wild fruits, greens, mushrooms, etc.)
Next
Summary
Report
Provisioning
Location
Point • 40.576N 022.964E
Media
No attachment added
Details
Cultivation for fodder/grazing,
1
Hunting:
1
Fishery:
1
Timber, firewood:
1
Non-wood products (Wild fruit
1
Medicinal plants:
1
Genetic resources (e.g. seeds
1
Water for drinking:
1
Water for non-drinking purpos
Save
Thank you
Successful Submission.
ppGIS
LIFE-IP 4 NATURA
End

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Natura 2000

Thank you!